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Design Data For The Engineer

Molded Test Pieces Give Property Data Needed for Engineering Design

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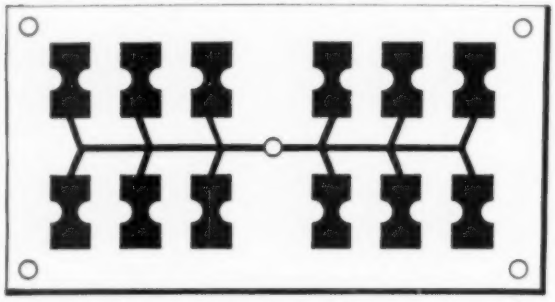

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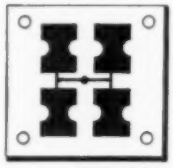

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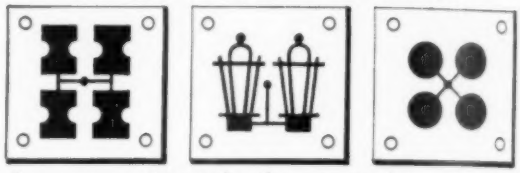

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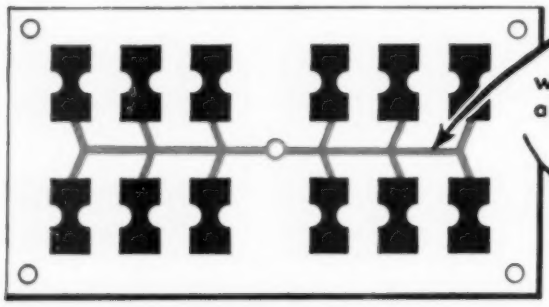

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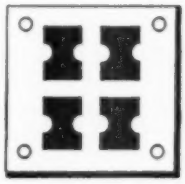

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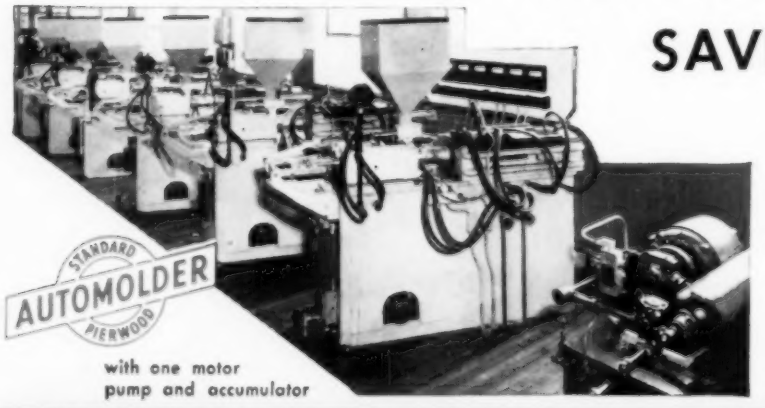

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At the March 2 meeting, the Western New England Section welcomed its 200th member into the fold. The milestone member, Clifford W. Pontbriand, American Optical Company (center) admires the cake his application inspired. Also beaming their approval are Edward W. Vaill of the Bakelite Company, technical chairman for the meeting, and George W. Martin of Noma Lites, Inc., section prexy.

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Book Reviews . . . .

MONOMERIC ACRYLIC ESTERS

E. H. Riddle—221 pages—published 1954 by Reinhold Publishing Corporation

In the Preface, the author states that "This book is designed to provide a background of information to serve as a starting point and guide to those working with acrylate and methacrylate esters on a laboratory, pilot plant and commercial scale." To achieve this purpose, Dr. Riddle and his collaborators in the Rohm and Haas organization have carefully reviewed the published information on the commercially available acrylic esters, and have condensed their findings into a concentrated and concisely written summary. The painstaking nature of their effort is attested to by the fact that over 40% of the nearly 700 references listed in the book refer to patents, and that their literature search appears to extend well past mid-1953.

"Monomeric Acrylic Esters" manifestly has accomplished its stated purpose. It definitely fills a void in the literature on these monomers, since no previous compilation of a comparable scope has been attempted. It provides the interested chemist with a convenient and much needed key to the literature on acrylate and methacrylate esters, with particular emphasis on their behavior in polymerization reactions. [The book contains seven Chapters: Introduction (5 pages), Physical Properties (7 pages), Storage and Handling (14 pages), Polymerization of Acrylic Esters (38 pages), Copolymerization (74 pages), Reactions of the Acrylic Esters (61 pages), and Analytical Methods (18 pages).]

It should be recognized that "Monomeric Acrylic Esters" is a book written by chemists and for chemists. As such, those SPE members who are engaged in chemical research, development or other technical activities on polymers will find it of real value. However, the average molder or fabricator will find relatively little of direct interest. [The book distinctly is not pitched at the "How-To-do-it-Yourself" technical level].

The review nature of Dr. Riddle's book renders criticism impractical on grounds other than the choice of subject matter or the emphasis placed on specific points. Actually, no criticism can be made on these scores, since it is evident that the author's position in the industry and the accumulated background available to him in the Rohm and Haas Company have resulted in an extremely well balanced presentation of the subject.

One can perhaps wish, however, that somewhat more emphasis had been placed on the technology and commercial applications of the acrylic esters, since so many of the patent references were directed as much to the technology as to the chemistry of the products in question. A separate chapter dealing with other esters not commercially available at the present time might have been more in keeping with the title. [For instance, the glycol esters, like "BCM," even if no longer commercially available, would seem to warrant at least passing mention in any consideration of the subject.] In the opinion of this reviewer, an index would contribute to the convenience of the reader in using the book, although the arrangement of Chapter sub-headings admittedly does minimize this problem. [However, if one were seeking information on copolymers of alpha-methylstyrene and acrylic esters, for example, its location by the chapter sub-heading method would be rather uncertain, since it is not listed as such, although a short discussion of such copoly-

(Please turn to Page 6)

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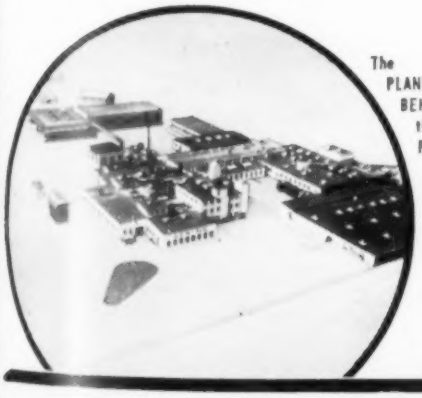

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Book Reviews . . .

(Continued from Page 4)

mers actually does occur in the section on "Copolymerization with Styrene." Finally, the publication is remarkably free from typographical and other errors, although there seems to be an error on Page 97 in the discussion on the styrene: methylacrylate ratio in the copolymer reported by Nielsen. The ratio is given as 1:5 and it apparently should be 1.5:1.]

None of these minor criticisms detracts in any way from the excellent job actually done by Dr. Riddle and his collaborators in this book, which can be recommended without reservation to polymer chemists whose interests relate to the acrylic esters.

D. E. Cordier

Statistical Quality Control—VIII
Statistical Correlation

— A Correction —

The equation which appeared in the March 1955 issue, in the first column on page 24, was in error. The correct equation should read

$$r = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{N}}{[\Sigma x^2 - (\Sigma x)^2/N]^{1/2} [\Sigma y^2 - (\Sigma y)^2/N]^{1/2}}$$

Our sincere thanks for catching this error goes to R. R. Dixon of the Electric Appliance Div. of Westinghouse at Columbus, Ohio.

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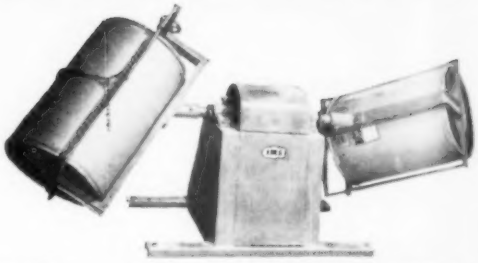

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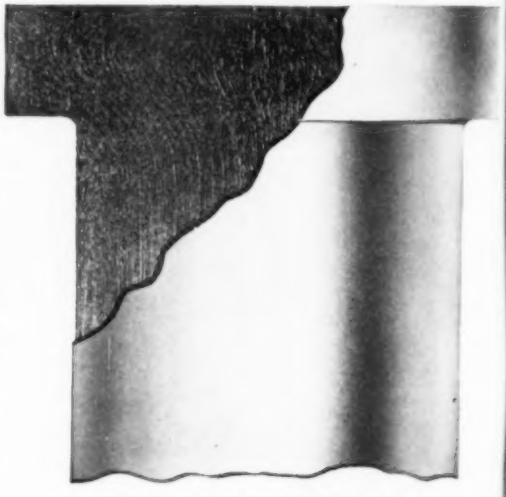

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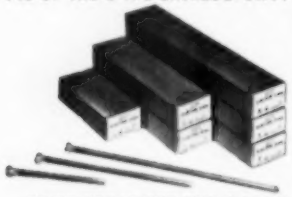

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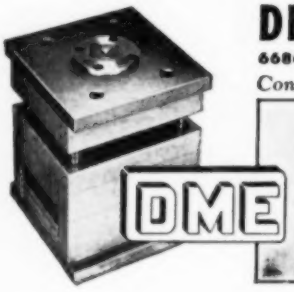

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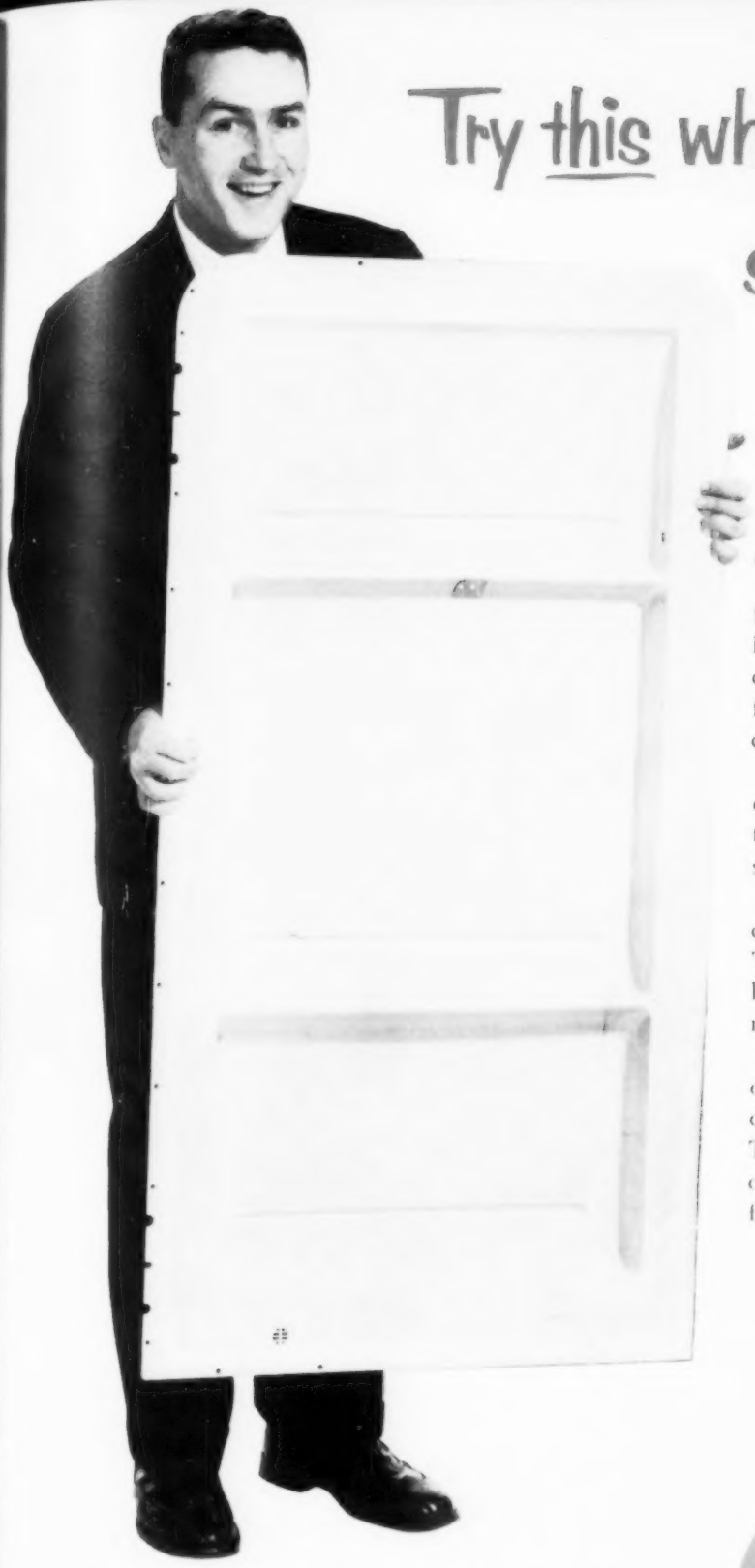

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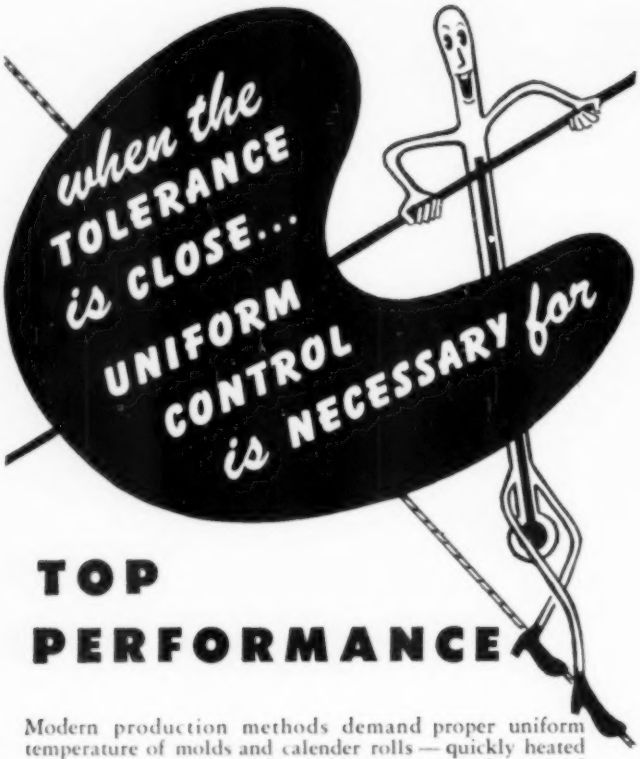

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The Sliding Friction of Teflon

— Discussion —

After the presentation of the paper "The Sliding Friction of Teflon" by Thompson, Turrell and Sandt at the 11th SPE Conference (paper published in April 1955 SPE Journal) several questions were asked by the audience. The questions and replies were as follows:

Q. Can you explain the flaking of "Teflon" at extreme pressures and high speeds?—Ralph C. Taylor, Naval Research Laboratories.

A. It is my opinion that under these conditions the "Teflon" reaches extreme temperatures and fails due to its lower shear strength at the high temperatures that probably result from the high speeds.

Q. Have you ever tried nylon against "Teflon"?—Hugh Winn, Firestone Tire and Rubber Company.

A. No.

Q. Can fillers be incorporated satisfactorily to levels higher than 40-50%, say 80-90%?—Hugh Winn, Firestone Tire and Rubber Company.

A. Reference is made to Du Pont Information Bulletin, Polychemicals Department #X-60. Data in this Bulletin show that tensile strength decreases perhaps 25% at 70 or 80% filler. Elongation drops to zero. Flexural modulus in general increases, but the amount of increase depends greatly on the type of filler. Flexural strength decreases to three or four thousand pounds per square inch at 70 or 80% filler. Impact strength drops to about 1/5 the value for unfilled "Teflon". Compressive strength rises markedly up to about 50% filler and then begins to decrease. Hardness (Shore "D") rises abruptly to about 70 for 20% filler and changes little thereafter. The linear thermal expansion for a composition containing 80% filler is about 1/10 that of unfilled "Teflon".

Q. What explanation is given for the effect of filler on the coefficient of friction?—F. L. Stiegler, National Vulcanized Fibre.

A. Apparently we are measuring in part the coefficient of friction of the filler itself on steel. If the filler is of very fine particle size, it can more or less yield with the sample on compression; but, if the filler is coarse, it supports more than its share of the normal force. Hence, coarse powders tend to give higher values for the coefficient of friction.

Q. Can any recommended maximum load and speed values be given for "Teflon" bearings?—W. C. Potter, Boeing Airplane Company, E. G. Johannes, Mineral Products.

A. We have just started a program aimed at finding out about this. Bearings are sometimes given a "PV Rating" where P is the pressure calculated for the projected area of the bearing and is given in pounds per square inch. The V term is the linear velocity at the bearing surface in feet per minute. The PV rating may be taken only as a very rough guide for design purposes. "Teflon" bearings are being used under conditions giving PV values of 10,000 and values as high as 30,000 have been used. The performance of the bearing is very strongly dependent on the geometry of the system, however, and these values cannot always be expected to apply.

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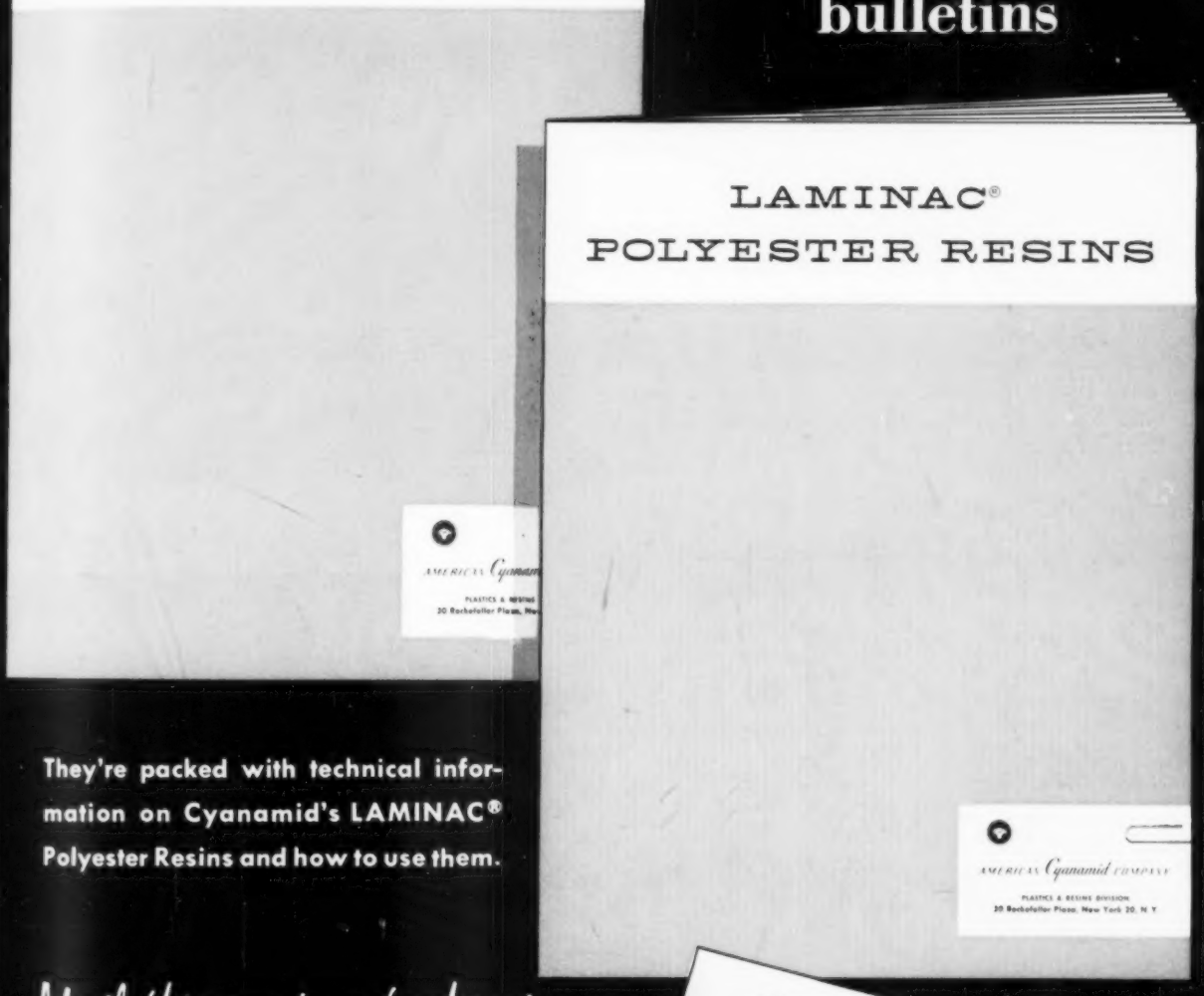

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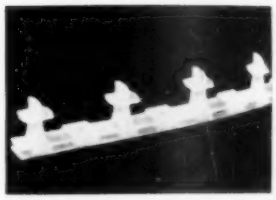

Wire supports of "Zytel" take any diameter wire bundle. They're lightweight, won't abrade wire insulation, are impervious to solvents.

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	170°F.	7,600 p.s.i.	D-638-46T
Elongation	−70°F.	1.6%	D-638-46T
	73°F.	90%	D-638-46T
	170°F.	320%	D-638-46T
Modulus of elasticity	73°F.	400,000 p.s.i.	D-638-46T
Shear strength		9,600 p.s.i.	D-732-46
Impact strength, Izod	−40°F.	0.4 Ft.-lb./in.	D-256-47T
	73°F.	1.0 Ft.-lb./in.	D-256-47T
Stiffness	73°F.	200,000 p.s.i.	D-747-48T
Flexural strength	73°F.	13,800 p.s.i.	D-790-45T
Compressive stress at 1% deformation		4,900 p.s.i.	D-695-44T
Creep in flexure		90	**
Hardness, Rockwell		R 118	D-785-48T

THERMAL			
Flow temperature		>480°F.	D-569-48
Coefficient of linear thermal expansion per °F.		5.5×10^{-5}	D-696-44
Thermal conductivity		1.7 B.T.U./hr./sq.ft./°F./in.	—
Specific heat		0.4	—
Deformation under load at 122°F. and 2000 lb./sq.in.		1.4%	D-621-48T
Heat-distortion temperature			
264 lb./sq.in.		150°F.	D-648-45T
66 lb./sq.in.		360°F.	D-648-45T

ELECTRICAL			METHOD
Dielectric strength, short-time		385 V/MIL	D-149-44
	step by step	340 V/MIL	D-149-44
Volume resistivity		4.5×10^{13} OHM-CM.	D-257-46
Dielectric constant,	60 cycles	4.1	D-150-47T
	10^3 cycles	4.0	D-150-47T
	10^6 cycles	3.4	D-150-47T
Power factor,	60 cycles	0.014	D-150-47T
	10^3 cycles	0.02	D-150-47T
	10^6 cycles	0.04	D-150-47T

MISCELLANEOUS		
Water absorption	1.5%	D-570-42
Flammability	self-extinguishing	D-635-44
Specific gravity	1.14	D-792-48T
Average mold shrinkage	0.015 in./in.	—
Compression ratio	2.1	D-392-38
Resistance to weathering	good	—
Basic color	light cream, translucent	—
Resistant to:	esters, ketones, common solvents, alkalies, weak acids	
Not resistant to:	phenol, formic acid, concentrated mineral acids	

Some of the physical properties are dependent on the moisture content of the nylon which may be as high as 2-2.5% under normal exposure.

**Term "creep in flexure" is a measure of the deformation under a prolonged standard load. Results here represent mils deflection in 24 hrs. of a 1/8" x 1/2" bar, 4" span, center-loaded flatwise to 1,000 lb./sq. in., minus the initial deflection.

NOTE: This table shows the typical property data for Du Pont "Zytel" 101 nylon resin. These values should not be used for specification purposes.

ZYTEL* nylon resin **ALATHON® polyethylene resin** **TEFLON® tetrafluoroethylene resin** **LUCITE® acrylic resin**

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BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Significance

Gilbert L. Peakes

Bakelite Co., A Division of

Union Carbide and Carbon Corp.

The subject of "Significance" is discussed in a rather general way, so that the reader who is becoming aware of statistical tests for the first time may get an idea as to what kinds of significance tests are available to him. We shall not attempt to give him a full set of the necessary numerical tables with complete instructions for their use, but will refer him to texts where such tables are given and their use fully explained. Here the thinking back of them will be discussed so that an intelligent application of the significance test which is the correct one for a given situation may become possible.

This article is the ninth in the series "Statistical Quality Control for the Plastics Molder" written by the S.Q.C. committee of SPE under the chairmanship of L. M. Debing.

INTRODUCTION

IN GENERAL, AN EVENT, or a set of measurements, will be called significant if it has a relatively low probability of occurring by chance. Probability measures are usually stated as fractions. For example, in tossing a coin, the probability of it showing a head is ½, and of a tail ½. Statisticians would write these fractions as 0.50 and 0.50. No one would expect the coin at any toss to stand on edge, therefore the total of all probabilities is 1. Symmetrical and unweighted dice have the property that the probability of stopping a roll with any given face up is 1/6. Whether or not a person knows all the probabilities (the "odds") in a crap game, his purpose is to bet so that he has a higher probability of winning than of losing.

Industrial data should lead to action which has similar favorable probability of being the right action. A person **would not** risk much energy or expense in taking an action where the probability of that being the right action (the chance of winning) is low. He **would** risk major expense where the probability that the action taken is the right one is high. Since 100% probability of being right is an impossibility, it remains to decide on action with a high success probability, but accepting the fact that full 100% for probability of success is never obtainable.

The subject of significance is discussed here under these headings:

I. General.
II. "t" for Comparison of an Average with a Standard.
III. "t" for Comparison of One Average with Another.
IV. "F" for Comparison of One Dispersion with Another.
V. "X^2" (Chi-square) for Comparison of Actual Counted Objects or Events with Expected Counts.

Calculations of each of the statistics "t", "F", or "X^2" requires subsequent appraisal by reference to a table showing significant values of the statistic. Since it is beyond the purpose of this series to provide a statistical textbook complete with tables, none are given here. All the references at the end of this paper will be found to contain one or more of the tables which are needed.

SIGNIFICANCE

I. General

Since this discussion will be read mostly by men, who usually delight in stories and cartoons about women drivers, we shall introduce the subject of "Significance" by a statement: "If while driving you see a woman's arm waving out of the car ahead, you can be sure of one thing —she has the car window open." Of course male drivers like to think that if it were a man's arm waving out of the car ahead, they could more definitely attach some significance to the other driver's signal. The male driver using a hand signal would be signifying, distinctly and almost certainly, that he was intending to stop, turn right, or turn left. Any driver who sees such an arm signal and is inclined to any doubt about what the driver will do, if a woman, is making a significance test. He compares what he sees with what he remembers of previous similar experiences, he decides as to the significance of what he sees, and he follows that decision with appropriately cautious action.

Many everyday situations occur in which such significance tests are instantly made, never calling for thought or figuring. In the handling of data on industrial processes, for example in the many activities where plastics fabricators must compare measured results with past experience or with standards, the significance of the numbers which represent measured qualities must be assessed by some figuring. The necessary figuring will be presented here as simply as possible and will lead to important knowledge about what goes on in your shop, so don't go away.

When a mold for a new part starts into production, the first few shots are checked for any gross errors or faults, but the rating of this mold as a day-after-day

producer will generally be postponed until it has been "run in." When the mold is judged to have settled down to a steady operating state, a close examination of its performance as compared to design specifications can be made with confidence. Everybody knew that the first few pieces would not be sufficiently significant of the long-run results which could be expected. Now that the mold (or press, or extruder, or mill, etc.) has settled into its stride, the figuring may begin.

II. "t" for Comparison of an Average with a Standard

The figuring to be done is a mathematical parallel to the reasoning which is automatic and swift in the mind of the driver who sees an arm signal ahead. It consists of deriving some sort of an appraisal figure from the measurements, comparing that appraisal figure with a similar figure which represents either an expectation or a summation of past experience, and then deciding what action to take.

In considering this subject of significance let's take a look at the sizing practices of the men's clothing industry. A man selecting an overcoat or topcoat will be offered his choice in either size 38, 40, 42, 44, etc., only even-numbered sizes being available. This means that in that industry it has been determined that 2 inches is the smallest "significant" difference needed to strike an economic balance between the desires and tastes of the customers as to fit, and the inventory and cost problems of the suppliers. Size intervals smaller than 2 inches, applied over different styles and weights, would be largely indistinguishable to the wearers. They would not enable the customer to make a "significant" choice of size.

Let us now look at some finer details. We shall look at one of the simplest types of significance problem as it might occur in a molding plant. Let's say that the mold for a certain part, with material and cycle specified, has been designed to produce pieces which shall have an average measurement, for a critical dimension, of 2.500 inches. The mold is run according to plan, and a series of heats produce pieces having the measurements shown in Table I:

TABLE I

	2.502 inches
	2.504
	2.498
	2.500
	2.506
	2.502
Sum	**15.012**
Average	**2.502 inches**

It is quite certain that the average measurement obtained is larger by .002 inches than the average which we tried for, but it is necessary to ask: "Is that difference significant?" By asking such a question when individual pieces can vary as much as these 6 do, we indicate that it is a matter of some doubt as to whether successive averages taken repeatedly would always be above 2.500 inches. This one was, but it contained an individual which was .002 inch below 2.500 inches. Might we not sometimes get several of these in one series and thus get an average below 2.500 inches?

It becomes obvious that we would like an answer to the question: "How often would individuals which vary this way, yield an average which is above 2.500?" If this question had the answer: "50% of the time," then we could be confident that our design was good and that the result was straddling the target perfectly. Suppose the answer were: "75% of the time." If under that condition we were to make the statement that: "Each future average of 6 pieces will be above 2.500," we would be wrong 25% of the time, because the average would be below 2.500 with that frequency.

Ideally we would like the answer to be either 100% or 0%, leaving all uncertainty out of the picture. The facts of life being what they are, such complete and unequivocal certainty is impossible. It is possible to derive an answer which will be right 90%, 95%, 98%, 99% of the time, etc., but full 100% is not quite attainable.

Now how about the method for getting a numerical answer to that question beginning: "How often - - -?" The method is, to calculate from the data a statistic called "t", which in words is defined as the ratio of a variable quantity to the standard deviation of that quantity. In order to have symbols to use we shall call the variable quantity x and write its standard deviation as s(x). In this symbol we are not indicating multiplication of s by (x), but using s to mean standard deviation, of whatever quantity is inside the parenthesis. Using these symbols we define t as

$$t = \frac{x}{s(x)}$$

The x may be any measured quantity which varies according to a pattern of some sort. It may represent a single measurement, an average of such measurements, the difference between a measured average and a standard, or the difference between two averages. In the numerical problem at hand, the statistical quantity of interest is the average. If we use $\bar{x}$ (pronounced x-bar) to represent the ordinary arithmetical average, then the pertinent t is:

$$t = \frac{\bar{x}}{s(x)}$$

The average, $\bar{x}$, is easily calculated, but the standard deviation of an average is less easy.

Using the Greek letter Σ (sigma) to denote "sum" and n to denote the number of measurements, standard deviation of an average is:

$$s(x) = \sqrt{\frac{n \Sigma x^2 - (\Sigma x)^2}{n^2 (n - 1)}}$$

This formula is the most convenient one for calculations. A different but exactly equivalent formula is usually given as the definition, but since it is both difficult and sometimes slightly inaccurate for calculations, we shall not consider it here.

Before going ahead to make the calculations from our data let's analyse the situation a little further. The standard deviation is a measure of fluctuations, but each measurement consists of a basic constant, 2.500, plus the fluctuating part. The table of dimensions may then be thought of like the figures in Table II.

It becomes obvious that calculation of a measure of the fluctuations, say the standard deviation, is concerned only with the second column where all the fluctuations are. It is obvious also that although the figures in the second column of Table II have been written as "inches", we could choose to write them as "thousandths", and thus make the decimals disappear. Then if we keep in mind that we are dealing with thousandths of an inch fluctuations around a base of 2.500 inches, we can change the data to the form of Table III.

TABLE II

Basic Constant	Fluctuating Part
2.500	+.002
2.500	+.004
2.500	−.002
2.500	+.000
2.500	+.006
2.500	+.002

TABLE III

+2
+4
−2
0
+6
+2

From Table III we derive:

$$\Sigma x = 2 + 4 - 2 + 6 + 2 = 12$$

$$n = 6$$

$$\bar{x} = \frac{12}{6} = 2$$

$$\Sigma x^2 = 4 + 16 + 4 + 36 + 4 = 64$$

$$s(x) = \sqrt{\frac{6 \times 64 - 12^2}{6 \times 6 \times 5}} = \sqrt{\frac{384 - 144}{180}} = 1.155$$

$$t = \frac{\bar{x}}{s(\bar{x})} = \frac{2}{1.155} = 1.73$$

This value of t, a statistic derived from the data, is now to be compared with a table of t values, which tells the frequency with which such a value of t could occur when calculated from measurements which follow a normal distribution, and for various amounts of data. In looking up the desired frequency, or probability, with which the found value of t could occur from chance causes only, we must look at that line of the table which gives the t values for so-called "degrees of freedom." For our purposes the degrees of freedom may be defined as equal to the number of individual measurements minus the number of averages used. For this example the degrees would be n − 1. Interpolation in the table on the line for n − 1 = 5 degrees of freedom indicates that for this much fluctuation as measured by the standard deviation, and for this average, a value of t as large as or larger than 1.73, could occur as often as about 7% of the time.

It will be noted that the value of t is proportional to the average, so that offhand one would say there would have to be a separate t table for every numerical value of x. Actually there is only one table, and that happy situation is the result of using the restriction that the true level of the variable we are putting into the numerator in the t calculation is zero. This means that for each occasion when we wish to calculate t from our data, we have to transform that data into measurements having a true value of zero.

The operation by which we simplified the calculation of s(x) by transforming into Table III was not just a simplification of the arithmetic. It was also a transformation of the measured variable to one having a true value of zero. Actually the transformed variable was (x − 2.500), or in words, "departure from 2.500." Therefore the t value we calculated, 1.73, gives a measure of how often a sample of 6 measurements, having a true value of x − 2.500 − 0, and a standard deviation as derived from these fluctuations, could give an average as large as the one we got, which was 2.502.

The appraisal of t − 1.73 said that this could happen by chance 7% of the time, and thus a statement that the true average of the measurement is greater than 2.500 (departure greater than zero) is likely to be true.

By the calculation of a t value and its appraisal in terms of probability, we have accomplished a **test of significance.** We have assumed that our set of measurements came from a situation where the true underlying value was 2.500. We calculated a measure of the fluctuation of the measurements around their average, and have learned from the table of t values that if the assumption is correct, then in only 7% of all possible sets of 6 measurements like these, could it happen by chance that the measured average could be as high as or higher than 2.502. Something that did happen, and that could happen only rarely by chance, quite probably happened due to some real cause. In this case the conclusion would be that the real cause is that the true value of the measured dimension is not 2.500 but some quantity larger than that.

In the language of the statistician, we have made a significance test. We found that the measured value was so far away from the goal of 2.500 that the departure was significant. In significance testing of this sort, a low probability (of occurring by chance) means high significance (high probability of being due to an assignable cause). This may be looked at in another way. We made an assumption, and if that assumption were true, the t test would lead to a high probability. The t test indicated a low probability, therefore we showed that the difference between the assumption and the fact was significant.

In the particular instance of these data we did not have the problem of deciding how often a similar set of measurements could be .002 inch away from 2.500 inches, plus or minus. The problem was to find the frequency with which samples of data could have an average which fluctuates up to 2.502 or higher. Since fluctuations around true value are expected to be half below and half above, and the t table is so arranged as to express that behavior, the 7% expectation for an average of 2.502 is just half of the 14% expectation indicated by interpolation in the table.

The method of calculating the statistic t from data as detailed above is a general one for comparing a measured average with some sort of a standard. This standard might be the long-time average of past experience, or a specification or design figure. Either way, there is supposed to be no fluctuation attached to the comparison standard. This method applies only to quantities which are measured, as in thousandths of an inch. Quantities which are counted, such as the number of pieces having visual defects, or the number rejected by a gage, are handled by a different method, to be treated later.

III. "t" for Comparison of One Average With Another

In Section II a variable quantity, an ordinary average, was compared with a standard having no variability. This does not cover one of the frequent comparisons which a plastics engineer encounters, where he wishes to compare the averages of two products, or the averages of one product when treated by two different procedures, etc. In such a case both of the quantities compared have some variability and it is necessary to take both into account.

For such a comparison we again calculate from the data a value of t, just as before, by dividing the value of a variable quantity by the standard deviation of that quantity, and also just as before, using the basic assumption that the true value of the quantity is zero. In order to get our original measurements transformed to a quantity

(Please turn to Page 16)

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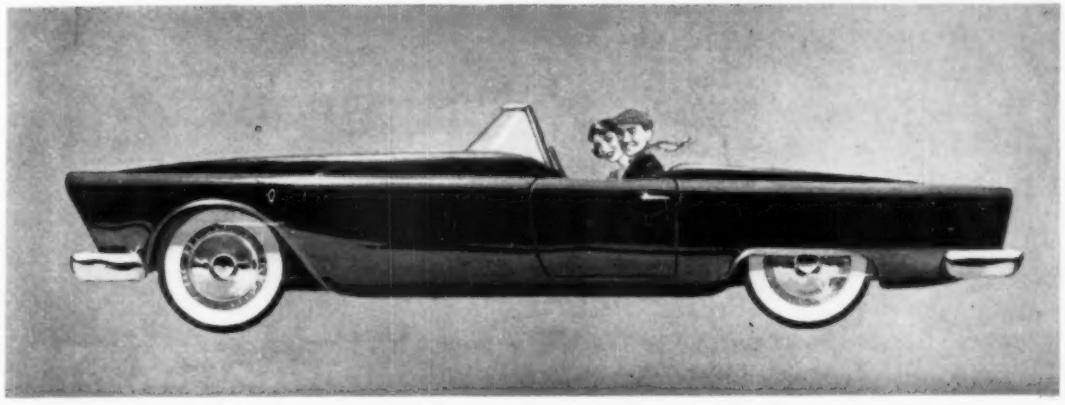

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Significance . . .

(Continued from Page 13)

whose true value could by hypothesis be zero, we subtracted from it some sort of a standard or design value, so that the variable we were really examining by our t test was the "departure from standard." In order to maintain the hypothesis that the true value of the quantity in the numerator for the t calculation is zero, we translate it for this case to the hypothesis that the true value of the difference between two averages shall be zero. In other words, our hypothesis says that the two averages we are comparing both come from the same true value, and differ numerically due only to the incidence of random errors or fluctuations of the measurement. Then, in symbols, we shall calculate:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{s(\bar{x}_1 - \bar{x}_2)}$$

The variable we examine now is changed from $(\bar{x})$ for one average to $(\bar{x}_1 - \bar{x}_2)$ for two averages.

The numerator is easily calculated and may be set up so that the difference is a positive number. The denominator is a little complicated but is calculated as follows:

$$s(\bar{x}_1 - \bar{x}_2) = \sqrt{\frac{n_1 \sum x_1^2 - (\sum x_1)^2}{n_1} + \frac{n_2 \sum x_2^2 - (\sum x_2)^2}{n_2}} \left[\frac{1}{n_1} + \frac{1}{n_2}\right]$$

$$n_1 + n_2 - 2$$

In this formula we have presented the general case where the number of measurements n_1 entering the first average $\bar{x}_1$ is different from the number n_2 of measurements entering the second average $\bar{x}_2$. If it can be arranged to have the same number n of measurements in both averages, then $n_1 = n_2 = n$ and the formula is much simplified. When this simplified formula for standard deviation is combined into that for t, we get a further simplification such that we no longer need averages but only sums:

$$t = \frac{\sum x_1 - \sum x_2}{\sqrt{\frac{n \sum x_1^2 - (\sum x_1)^2 - (\sum x_2)^2}{n - 1}}}$$

Although this formula appears to be written for a difference of sums it actually refers to a difference of the corresponding means. Within this formula n is the number of measurements in **each** set, $\sum x^2$ represents the squared individual measurements summed over **both** sets, and t has, as before, degrees of freedom equal to the total number of measurements minus the number of averages used, which in this formula will be $2n - 2$.

To see how this works out using actual measurements, let's say that a substitute material is offered the molder and that a series of heats with the new material on the same mold and conditions as before, produce the measurements indicated for Material 2, where the original measurements are repeated as Material 1, both in Table IV.

TABLE IV

Material 1	Material 2
2.502	2.502
2.504	2.498
2.498	2.497
2.500	2.499
2.506	2.501
2.502	2.497

Data after transforming, 1000 (x − 2.500)

2	2
4	−2
−2	−3
0	−1
6	1
2	−3
—	—
$\sum x_1$ 12	$\sum x_2$ −6
$\sum x_1^2$ 64	$\sum x_2^2$ 28
$\bar{x}_1$ 2	$\bar{x}_2$ −1

$$\sum x^2 = \sum x_1^2 + \sum x_2^2 = 64 + 28 = 92$$

Now having generated in Table IV the raw material for our calculation, we compute:

$$t = \frac{12 - (-6)}{\sqrt{\frac{6 \times 92 - 12^2 - (-6)^2}{6 - 1}}} = 2.09$$

In this case we have no basis for supposing that $\bar{x}_1$ should be larger or smaller than $\bar{x}_2$, and therefore we shall use the appraisal of t which considers that the difference between the two averages could be either way. We enter the t table at degrees of freedom $2n - 2 = 12 - 2 = 10$, and we find that the value we calculated, 2.09, could occur by chance about 6% of the time, if no difference really exists between the two materials we are comparing. Since there is a very low (6%) probability that this difference could occur by chance, there is a complementary high (94%) probability that there is a real difference. If action is taken based on the difference as we found it, there is a 94% probability that this action is being based on a correct appraisal of the difference.

IV. "F" for Comparison of One Dispersion with Another

An examination of a previous article in this series by R. S. Fay, The Normal Frequency Distribution, in the SPE Journal for October, 1954, suggests on page 29 in Figure 4 diagram B that the average of a distribution may be at a satisfactory point but that the variation around that average gives an appreciable number of units which are outside desired limits. Diagram C suggests another distribution about the same average but having no individuals outside limits. It might be said that the dispersion represented by diagram C is satisfactory and that represented by diagram B is unsatisfactory.

In the case of an unsatisfactory processing result, it is usually up to the plastics engineer to go out into the shop, find the cause or causes and get remedies applied. Fay suggests some causes for dispersion which is too large, and cites worn equipment as one such cause. Maintenance work or replacement would be the remedy for worn equipment. After the maintenance or replacement remedy has been applied to a situation where the dispersion is too high, a check-up is desirable to see whether the remedy has in fact been successful in reducing the dispersion. For this check-up a numerical means of measuring dispersion must be applied. Fay's diagrams suggest that there is such a measure of dispersion, and we shall now discuss its application. In general, it will not be that

of describing the distribution curve in its entirety, but a single figure related to it.

Using Tables III and IV we already derived dispersion measures which were called standard deviations of the quantities of interest, for example of an average or of the difference between two averages. For the purpose of comparing dispersions directly use will be made of the dispersion measure called "variance." To symbolize standard deviation we wrote s, followed by a parenthesis containing the quantity for which the standard deviation was being derived. To symbolize variance we write s^2, the square of the standard deviation, also followed by a parenthesis containing the quantity whose variance is being derived. For a single quantity for which we need a dispersion measure, the calculation of variance is made first, and the value is then used directly as variance, or the square root is taken to get standard deviation, according to what use will be made of the dispersion measures.

In general, if dispersion is too high, there will be too many individual parts or products which are outside limits even though the average is well inside limits. Therefore for examining dispersion directly we are interested in the dispersion of the individuals, as measured by variance. This variance of individuals is calculated as:

$$s^2(x) = \frac{n \Sigma x^2 - (\Sigma x)^2}{n(n-1)}$$

For such a calculation we can use the data already presented in Table IV, from which we derive:

$$s^2(x_1) = \frac{6 \times 64 - 12^2}{6 \times 5} = \frac{240}{30} = 8.0$$

$$s^2(x_2) = \frac{6 \times 28 - (-6)^2}{6 \times 5} = \frac{132}{30} = 4.4$$

Suppose we transform the former problem about the difference in averages of these two materials and ask the question "Do these two materials differ significantly in their dispersions?"

The answer is obtained from a table after calculating a statistic called F, which is derived for this problem as:

$$F = \frac{s^2(x_1)}{s^2(x_2)} = \frac{8.0}{4.4} = 1.81$$

In similarity to the tables which show what values of t can be attained by chance, there are tables which show what values of F can be attained by chance. In the t table there is a restriction that the true value of the variable for which we have calculated a t value shall be zero. Similarly, for the F table there is a restriction, namely that the true variance underlying each of the two groups of measurements shall be the same even though the two estimates from data, $S^2(x_1)$ and $S^2(x_2)$, differ numerically. In the calculation of F in instances where, as here, there is no expectation that one of the variances should be larger than the other, the larger variance is always to be put in the numerator.

The levels which the value of F can attain by chance sampling from a situation of constant true variance depend on the quantity of data in each of the variance estimates entering F. Naturally, if the amount of data in each of the two variance estimates is large enough, the value of F calculated will be very close to 1. In small samples the ratio can be much larger. We would like to have the table tell us how likely it is that an F ratio as large as or larger than the one we got, namely 1.82, could occur by chance if the underlying true variances were the same. The usual F table is arranged to show, at the top of each column, the number of degrees of freedom used to estimate the variance in the numerator, and at the left of each row, the number of degrees used in the denominator. Within each box at the intersection of a row and column are two values for F, the smaller one showing how large F could be in 5% of chance samplings of these sizes, and the larger one showing how large F could be in 1% of chance samplings.

For our specific problem the degrees of freedom are 5 each for numerator and denominator. The figures in column 5 at row 5 of the table are 5.05 and 10.97. Since our calculated F at 1.82 is much smaller than the 5% value from the table, the conclusion is that a value of 1.82 could occur by chance much oftener than 5% of the time. Ordinarily, if we wanted to make a statement that the dispersion of one of these samples is significantly greater than the other, we would want support for that statement by a finding that the F value was 5.05 or larger. We might even be so cautions as to require F to be 10.97 before we would be willing to state significance.

Again, we have made a **significance** test. We have decided that the two variances, 8.0 and 4.4, are not **significantly** different, because such a difference, using these amounts of data, could occur too often due to mere chance. With more data, an F ratio at 1.82 could be called significant. For example, the table tells us that if our calculated F were obtained from variances having 30 degrees of freedom in the numerator and 32 degrees in the denominator, it would only 5% of the time be as high as or higher than 1.82. For 30 and 32 degrees of freedom, then, we could judge F at 1.82 to be significant. For less degrees, such as 5 and 5, we have to say that significance is not shown.

At this point a word of caution is in order. We **have not shown that the variances of these two lots of material are alike.** We have merely found that with this small amount of evidence, **we are unable** (unwilling) **to say they are different.** They may very well be different, but the amount of evidence we have does not convincingly show it, that is, the difference is not shown to be **significant.**

A common need for evidence about dispersion occurs in examining the weights of thermosetting preforms, which of course have some variation. If the variation is excessive, there will be "short" moldings from the light ones, and perhaps gage-rejected moldings from the heavy ones. Excessive variation will cause the average preform weight to be kept high to avoid shorts, thus wasting a fraction of preform weight on every piece, and perhaps bringing rejects from the gaging operation. With greater preform uniformity, in other words smaller dispersions, more efficient use of material is possible. The F test permits the comparison of weight-uniformity measurements at various preforming machine speeds, at different feed shoe adjustments, between batches of material, etc. It can also find many other applications in the operations of plastics users, for example, uniformity of weight or thickness of laminates or sheet material, uniformity of incoming containers of material, and as shown by our example, an appraisal of whether a maintenance job has in fact accomplished the intended improvement in dispersion.

V. "X^2" for Comparison of Actual Counted Objects or Events with Expected Counts

The tests of significance discussed above have uniformly applied to quantities which are measured, for example in units of diameter, weight, thickness, strength, etc. Now we come to consider quantities which are not measured but counted, and here, just as in the cases of

measured quantities, it is possible to make a test of significance. The general procedure is the same as before. We calculate from the counted objects a statistical quantity, we take it to a table showing how often the quantity could attain that size due only to chance causes, and determine whether the statistic we calculated could have occurred frequently or only seldom, under the condition that nothing but chance causes are operating.

The statistic which serves for counted data is X^2, pronounced Ky-square. In order to calculate it from counted quantities, it is necessary to have some sort of expectation as to what the count should be. This expectation may sometimes be derived from a specification, or may be the result of experience averaged over a period.

As an example of the kind of data we are thinking about, suppose the shop has several machines of the same kind, perhaps presses, pumps, preformers, extruders, and each is in equal use for similar service. Suppose further that these machines require shut downs for a specific job of maintenance, which becomes sufficiently frequent and troublesome so that a record is kept of how often such maintenance shut down occurs on each machine. Let's say the record for a specific period looks like Table V.

TABLE V

Record of Machine Shut Downs

	Machine Number				
	1	2	3	4	Total
Number of shutdowns	9	3	5	7	24

It is desired to find out whether these unequal results indicate significant differences between machines, or whether such unequal results could reasonably be due to chance.

Before we can calculate the statistic X^2, we must have an expectation of shutdown frequency against which to compare the actual shutdown frequency. Since these 4 machines contain the entire record of our experience regarding shutdowns, and since we believe that they are getting equal use and therefore equal expectation of shutdowns, we reason that over a period each should have average shutdowns, namely $\frac{24}{4} = 6$. We assign the symbol to designate the observed count and E to designate the expected count, then define X^2 as:

$$X^2 = \frac{\Sigma\ (O - E)^2}{E}$$

For these results we then calculate:

$$\frac{(9-6)^2 + (3-6)^2 + (5-6)^2 + (7-6)^2}{6}$$

$$= \frac{9+9+1+1}{6} = \frac{20}{6} = 3.33$$

The next step is the appraisal of this figure 3.33 to see whether it is **significant**; that is, does it have a high or low probability of occurring by chance from machines which are really alike?

The X^2 table has an arrangement much like the t table, with columns corresponding to frequency, or probability of occurrence, and rows corresponding to degrees of freedom. Before we can refer our value 3.33 to the table we must know the degrees of freedom. For X^2 the degrees of freedom are defined as the number of cells in the table which might be filled with fictional data, but restricted so that the total of the fictional values will be the same as the total of the actual values. In Table V we could freely put in 3 fictional values, but we would not have freedom to put in anything we chose for the fourth—we may only put in a figure such as to bring the total to 24. Thus for these data the degrees of freedom are 3. Looking on the line for 3 degrees of freedom in the X^2 table, we see that a value of 3.33 or larger could occur, due to chance alone, about 33% of the time. Since such a value could come so frequently by chance alone, we would not be justified in saying that these machines are behaving differently. We have made a **significance** test; we conclude that such differences as we see here are not significant.

The person unfamiliar with statistical methods might very likely look at the shutdown records of machines 1 and 2 and conclude offhand that number 1 is "obviously" worse than number 2 since it has 3 times as many shutdowns. Our statistical test of significance says that this conclusion is untenable. We made the above test from a X^2 which contained the records of machines 3 and 4 also. If we chose to compare only machines 1 and 2 by means of X^2, not having any data on machines 3 and 4, the expectation would be the average of numbers 1 and 2, which is still 6, and we would calculate:

$$X^2 = \frac{(9-6)^2 + (3-6)^2}{6} = \frac{9+9}{6} = 3.00$$

This value has only 1 degree of freedom and corresponds to a probability of about 8%. Thus if there were only 2 machines in the picture, number 1 and 2, it would be much more probable that 9 shutdowns against 3 would mean something. However, as a larger group of machines is considered, it is more probable that the group would contain extremes in both directions, and selecting only those extremes for comparison would not be a fair basis.

It should be noted also that there is some risk in applying the X^2 test to small numbers of counted objects. This is because counted objects may only vary by whole units, consequently a change of one unit among a few units gives a relatively large change of X^2 and makes the value somewhat unstable. This means that meager data should be supplemented by additional information before important action is taken.

The above application of X^2 applies where the events counted are independent, for example forced shutdowns of machines, none of which is in any way associated with shutdowns of other machines. Another important application of X^2 occurs where the counted objects or results are not independent but contingent. The contingency feature comes in, for example, where the quality of production of plastic parts is rated by counting the numbers of accepted and rejected parts produced in a given period. With the total number of parts turned out in the period as a restricting fact, the number of rejected parts counted within that amount of production will be contingent upon the number of accepted parts. An example of such a set of contingency data is given in Table VI below, adapted from Duncan, p. 429.

TABLE VI

Actual Numbers of Pieces Produced

Shift	Rejected	Accepted	Totals
8-4	48	921	969
4-12	63	902	965
12-8	75	851	926
Totals	186	2674	2860

(please turn to page 24)

Giant battery cases weigh less... because they're made with DYLENE* POLYSTYRENE

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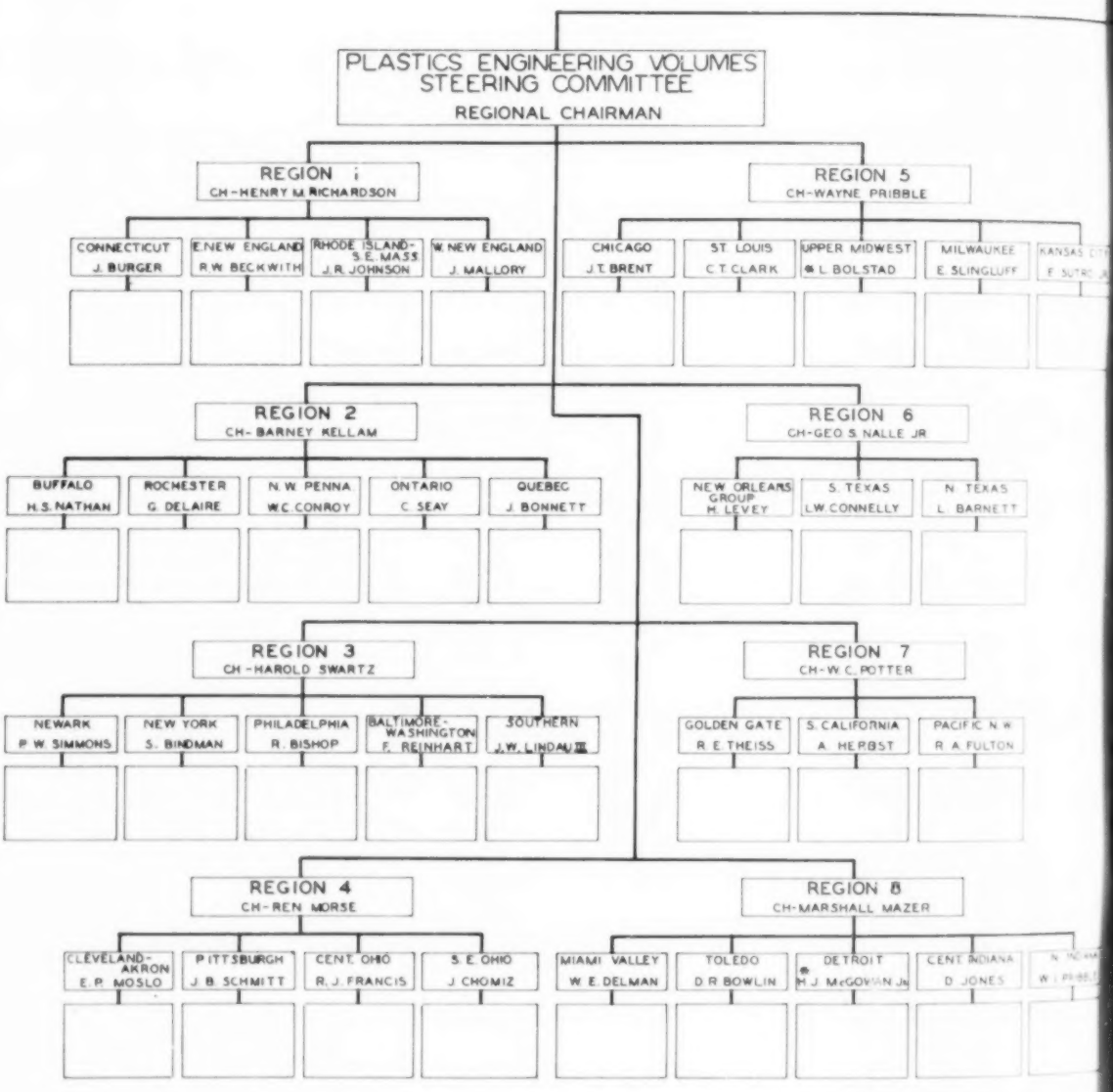
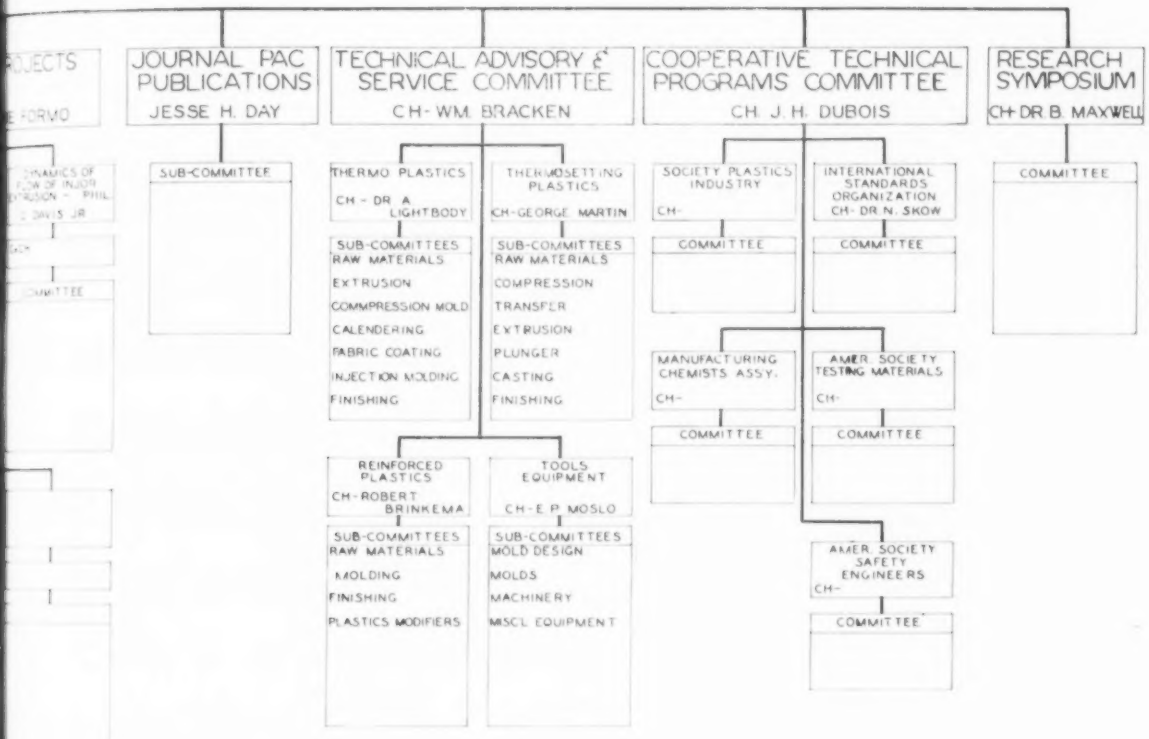


FOOTNOTE 1. PLASTICS ENGINEERING VOLUMES CO-CHAIRMAN FOR EACH SECTION WILL BE NATIONAL COUNCILMAN EXCEPT WHERE ● APPEARS. ALTERNATES HAVE BEEN SELECTED.

2. MISC'L. PROJECTS ARE PREVIOUS. PROJECTS NEARING COMPLETION – NEW PROJECTS WILL ORIGINATE IN LOCAL SECTIONS.

OFESSIONAL ACTIVITIES COMMITTEE

CHART



The National Professional Activities Committee (PAC)

Important appointments to the operations positions of the Professional Activities Committee have now been made. These are the men who will spearhead the work on PAC's projects throughout the entire Society. From these men you will be able to find out the details on PAC and through them you can offer your "support of the Society's objects" by contributing to its Professional Activities.

Here is the PAC organizational chart. Keep in touch with the chairman of your area. He is a very important person.

The members of the Statistical Quality Control Committee in addition to the chart above, are;

Co-Chairman: E. C. Harrington, Jr. Committee: Malcolm Young, John A. Kudlock, R. S. Fay, Delmer C. Dague, John D. Hinchen, Dorian Shainin, Harold Gulde, Leonard A. Seder, Gilbert L. Peakes.

Effects of Mold Temperature on the . . .

Behavior of Thermoplastics

Gordon B. Thayer
Dow Chemical Co.
Midland, Michigan

INTRODUCTION

The several factors which control the nature of a molded part usually result in a combined effect upon the finished piece. Sometimes one kind of control, injection pressure for example, is dominant, and the nature of the piece may be altered readily over a wide range of different aspects by changes in the injection pressure only. If this happened often enough, many of us would begin to think injection pressure is the only control required. Conversely, some molds do not seem to respond to injection pressure at all over the entire working range of the molding machine. In such cases, the effect of injection pressure is concealed or nullified by some other control of much greater dominance.

The principle of dominance of control factors must be recognized in all kinds of activities, including engineering for plastics molding. Dominance is a characteristic which varies according to the combinations of applications, materials, requirements, and other conditions specific to an individual problem. Dominance must be separated from the basic effects of each individual control.

Mold temperature is a control factor in the injection molding of thermoplastics. Dominance in some cases has made it seem to be the only control necessary. Concealment and nullification have occurred also. It is generally recognized, however, mold temperature exercises control, along with other control factors, over four aspects of injection molding:

1. Resistance to Plastic Flow
2. Physical Properties of the Molding
3. Surface Finish
4. Length of the Molding Cycle

RESISTANCE TO PLASTIC FLOW

Mold temperature affects resistance to flow in the mold cavity in an inverse ratio. As the mold temperature increases, the resistance to flow decreases. An increase of mold temperature in the range of 90°F. to 150°F. is usually all beneficial in assisting the flow and in decreasing the pressure required to fill for most of the commonly used thermoplastics.

In the temperature range above 150°F., a warmer mold becomes so much easier to fill, pressure control sometimes becomes so difficult it is impossible to mold at all. It is likely most injection molds may have a limiting maximum temperature beyond which they cannot be operated, even with all of the known means of refined pressure control available.

If the mold is too warm, the effective pressure of the plastic inside the cavity is likely to become so great the molding will stick in the mold and be warped, scored, cracked, stretched, or broken upon ejection, if the press can pull the mold apart. Also, it is difficult to control packing and the resultant orientation stresses in the molded piece. Flashing may occur.

If the mold is too cool, it may offer so much resistance to plastic flow the piece may not fill completely. This may not be always a result of insufficient injection pressure or lack of clamping force. It is believed the effect of mold surfaces which are too cool is to reduce the speed of filling so much the plastic cools enough to become extremely stiff and incapable of further flow.

The rate of stiffening of some thermoplastics, particularly cellulosics, is subject to considerable control by means of various additive ingredients. Such materials can be "tailored" to mold easily to some extent. Other thermoplastics, such as polystyrene and polyvinyl chloride, are much less susceptible to control over their rate of stiffening and molding technology becomes necessarily more critical. Crystalline thermoplastics, such as polyethylene, polyamides, and chlorinated ethylene polymers, offer very little if any means of control of their rates of stiffening and molding technology becomes extremely critical to the point where mold temperature control may involve insulation between the steel mold wall and the plastic in order to decrease the rate of heat transfer and avoid the necessity of mold temperature cycling.

PHYSICAL PROPERTIES OF THE MOLDING

It is likely mold temperature exercises indirect effects, mainly, upon the physical properties of injection molded thermoplastics. An exception is probably in weld strength.

A cool mold is believed to chill the advancing envelope of rubbery plastic skin, either because of direct removal of heat or because of slowing the flow sufficiently to provide time for excessive cooling of the skin. When the skin is too cool and too thick, welding of two plastic fronts is not effected satisfactorily. Experience has shown weld strength improves most responsively as mold temperature is increased.

A considerable amount of experimental work has shown tensile strength improves to some extent as the effective pressure in the mold increases. Mold temperature is often a factor in the increase of effective pressure, and it is reasonable to believe it is this indirect influence of mold temperature which is involved.

Thermoplastics which depend upon laminar structure for high impact strength or pearlescent effects tend to suffer loss of these properties progressively as mold temperatures are increased. This is probably an indirect effect also. Higher mold temperature probably results in greater effective pressure and faster fill time. Higher pressure tends to force the layers of plastic together more tightly and thereby bond them more securely. Faster fill time brings the pressure to bear sooner while the plastics is still hot enough to be bonded easily.

SURFACE FINISH

Mold temperature affects the surface luster of nearly all thermoplastic materials. Some materials are affected little, however. Generally these are the ones which can be "fire polished." The surface of such materials flows or shrinks into a shiny appearance when the temperature is raised sufficiently above the softening point.

High impact polystyrene compounds usually exhibit surface shrinkage of reticulate or orange peel nature at temperatures near or above their softening points. Such materials need to be pressed firmly against a lustrous mold wall and held in tight contact until there is no longer any opportunity for surface shrinkage to occur. The mold must be warm enough to soften the skin after its first chilling contact with the mold wall and keep the skin soft enough to conform intimately to the mold surface after the cavity has filled and then had pressure built up to "iron" the plastic against the mold wall.

Flow lines and welds are ironed out in the same fashion. The mold wall must be warm enough to soften the plastic skin sufficiently to allow the available pressure in the mold to force the plastic tightly against the mold wall. Air is likely to be trapped at folds and welds, and because it must occupy some volume no matter what pressure is employed to confine it, a small line or surface depression usually will remain. Good venting helps minimize the residual air. Poor venting has been know to mask the beneficial effect of proper mold temperature.

Surface blisters or silver streaks sometimes are subject to control by means of mold temperature. If the skin envelope breaks because the mold is so cool it makes the skin thick at the walls, the plastic temperature is usually increased which weakens the center part of the envelope. Excessive injection pressure also is likely to be employed and this causes the weak envelope to break and then immediately reform. Air is trapped between the old and new envelopes and is forced violently against the mold wall where it breaks up into many small bubbles. There are possibly fourteen to seventeen other causes of the envelope breakage and the formation of these blisters.

Surface "cottoning" is subject to control by means of mold temperature. Occasionally a condition is encountered in which the molded surface may be rubbed firmly with the ball of the thumb and fibrous cottony material will be rubbed off. Warmer mold temperature has been observed to stop this difficulty which has occurred on cellulosics and polystyrene. Possibly the mold chills the skin of plastic and makes it shrink and shatter. Heat then escapes from the molding so rapidly the shattered skin cannot be remelted into the body of the molding.

LENGTH OF THE MOLDING CYCLE

Mold temperature often is a control factor in the length of the molding cycle. When the cycle time is the dominant factor in the entire molding operation, the basic effects of mold temperature are often neglected.

It is true the transfer of heat from the molded plastic part to the wall of the mold is expedited by maximum temperature difference between plastic and mold wall. This usually means the plastic will cool faster in a cold mold than it will in a hot mold. Many times it is effective to operate the mold as cold as possible and produce parts on a short cycle.

Sometimes a cold mold does not produce on the shortest cycle. The plastic temperature may have to be high to allow the mold to be filled, and the extra heat may require too much time to be removed from the plastic. Sometimes a cold mold produces stress in the molding so severe the piece has to be kept in the mold longer to prevent warping.

Optimum mold temperature for shortest cycles may not be the lowest possible mold temperature in all cases. The extra time requirements to remove excessive heat or to stiffen the part to resist warping are facts just as true as the increase in heat transfer rate to a cold mold surface, even though they may have been less obvious to early observers of injection molding problems.

CONCLUSIONS

Plastics engineers are well qualified to understand the basic effects of various control factors. These facts are merely engineering tools of not great significance.

The engineering part of plastics engineering comes about through arranging the control factors in the best possible solution of specific problems and weighting the factors in accordance with their position of dominance. Engineers will do well to keep this in mind as one of the dominant aims of their profession. This may help them be prepared to deliver the service for which they are employed, and it may help their employers to a better understanding of the kind of magician an engineer is.

Discussion

Do you think an optimum mold temperature could be assigned to specific materials?

I think an optimum mold temperature should be assigned to specific materials for test purposes. For example, high temperature polystyrene of the heat resistant type is molded in test bar molds which are far too cold for this material. The heat distortion temperature as measured by standard A.S.T.M. methods is a meaningless figure in such cases. The mold temperature should be 180 F. for high heat polystyrene in my estimation. This would give the material a better chance to show some of its heat resistant properties and it would be molded under conditions which are far more conducive to good properties. Of course, the as-molded heat distortion test has relatively little meaning anyway, and we test most of our materials in the annealed condition in order to learn what we call the inherent heat resistance of the material. It is difficult to assign an optimum mold temperature according to formulation for general molding practice because the nature of the molds is such that temperature cannot be controlled exactly in all molds. If it were possible to maintain the same temperature over the entire surface of any given mold, it would be possible to specify the optimum molding temperature. In general, high heat materials should have higher mold temperatures in order to reduce the molded-in orientational stress.

What heat medium is most practical where temperatures of 550 F. to 600°F. are used?

As far as we know there has been no satisfactory answer to this question. Some people prefer to use a heat transfer oil, but they find the oil breaks down after long continued use. Proper maintenance of equipment and changing of oil can do much to alleviate this problem, and probably oil would be satisfactory. Some have tried the family of materials manufactured by Dow Chemical as Dowtherm and have had good results. The Dowtherms provide vapor phase heating at low pressure. They require extremely well sealed equipment because they can go through very small openings. Dowtherms would not be recommended for mold temperature control except under

Significance . . .

(continued from page 18)

In this table, the number of rejected parts produced on the 8-4 shift is not a number which stands by itself. It is a part of the work-day's production and is contingent upon the number of accepted parts within that production.

For contingent data like this, just as for the independent data on machine shutdowns, it is necessary to have some sort of an expectation for the relative numbers of rejected and accepted parts. This could be based on any facts which were pertinent, but the easiest is to use the assumption that the percentage of rejected parts in the total production should be the same on all 3 shifts. This assumption leads to the calculation of an expectation for each cell of the table, which is equal to the product of the row and column totals for that cell, divided by the total number in the table. Thus the expectation of rejects for the 8-4 shift would be equal to:

$$\frac{186 \times 969}{2860} = 63$$

The expectation of accepted parts for this shift may be calculated as:

$$\frac{2674 \times 969}{2860} = 906$$

It may also be determined by difference:

$$969 - 63 = 906$$

since the expectations are calculated without any assumption which could change the total production by the shift.

A series of such calculations sets up the figures entered in Table VII, where the marginal totals must be the same as those in Table VI.

TABLE VII

Expected Numbers of Pieces Produced

Shift	Rejected	Accepted	Totals
8-4	63	906	969
4-12	63	902	965
12-8	60	866	926
Totals	186	2674	2860

X^2 must now be calculated using all 6 of these expectations:

$$X^2 = \frac{(48-63)^2}{63} + \frac{(63-63)^2}{63} + \frac{(75-60)^2}{60} + \frac{(921-906)^2}{906} + \frac{(902-902)^2}{902} + \frac{(851-866)^2}{866} = \frac{15^2}{63} + 0 + \frac{15^2}{60} + \frac{15^2}{906} + 0 + \frac{15^2}{866} = 7.83$$

The degrees of freedom are obtained as before by counting the number of cells which we are free to fill with fictional data. In the rejected column we could freely insert 2 values, but the third would then be set by the restriction that the column total must remain 186. Having filled the "rejected" column with fictional data, the "accepted" column is also set by the restrictions of the shift totals. Therefore although there are 6 items of data concerned here, our degrees of freedom are only 2. This requires comparison of the calculated X^2 value, 7.83, with the X^2 table on the line for 2 degrees of freedom, and we find the tabular value to be 7.824 in the column for probability .02. This means it is only 2% of the time that X^2 in such a set of data could be as large as or larger than 7.824, if there were no differences between shifts. We therefore choose to believe it 98% probable that there is a real difference between shifts. Putting it another way, we say that the value of X^2 is in this case significant.

In most calculations of X^2, the result is usually clearly significant or clearly non-significant. For borderline cases a small adjustment of the calculation is advisable. This consists in reducing each of the numbers to be squared in the numerators of the X^2 components by 0.5. Thus if the last X^2 above turned out to be borderline in significance we would make a new calculation:

$$X^2 = \frac{14.5^2}{63} + \frac{14.5^2}{60} + \frac{14.5^2}{906} + \frac{14.5^2}{866} = 7.31$$

In these data the adjustment makes no change in the conclusions; with less decisive data it might make a difference and the recalculation would be recommended.

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Mold Temperatures . . .

(continued from page 23)

the most careful maintenance conditions. As far as we know no one is using Dowtherm for this purpose. Electric heating probably is satisfactory providing the mold requires continuous addition of heat. Very few molds are in this category, although many molds are controlled by a combination of tempered water and electric heaters to heat some spots which are not easily heated by the water.

Other than mold temperature control, how can you reduce surface effects due to air splattering when the advancing skin breaks?

Many times the surface defect known as silver streaking is caused by air trapped in the granules in the cold end of the heating cylinder. Sometimes the injection plunger has too close a clearance in the bushing and the air cannot escape back through the throat of the machine. Sometimes the column of granules between the end of the plunger and the torpedo is so short the air is not forced out before the plastic passes over the torpedo. Sometimes the temperature in the cold end of the heating cylinder is so high the surface of the granules melts and the centers remain hard. In such cases the air between the granules is trapped by the sticky plastic all around. Sometimes the injection plunger is not exerting sufficient force to squeeze the air out of the granules, the adjustment of plastic temperatures may allow higher injection pressure without causing too high pressure to be encountered in the mold. Sometimes the use of small granulations such as fines eliminates the problem because the fines can be crushed together more readily than the larger particles even though there is probably more air trapped in a given volume of fines than in a given volume of pellets. Occasionally excessive external lubrication allows the skin of plastic to melt at a very low temperature around the granules and traps the air. For this reason lower cylinder temperatures sometimes are of assistance, and higher temperatures can be employed to warm the granules to a softer condition so they can squeeze together and force the air out. Generally there is no sure way of telling which direction to move in elimination of air from the granules to stop the silver streaking problem.

Craftsmen of the 20th Century

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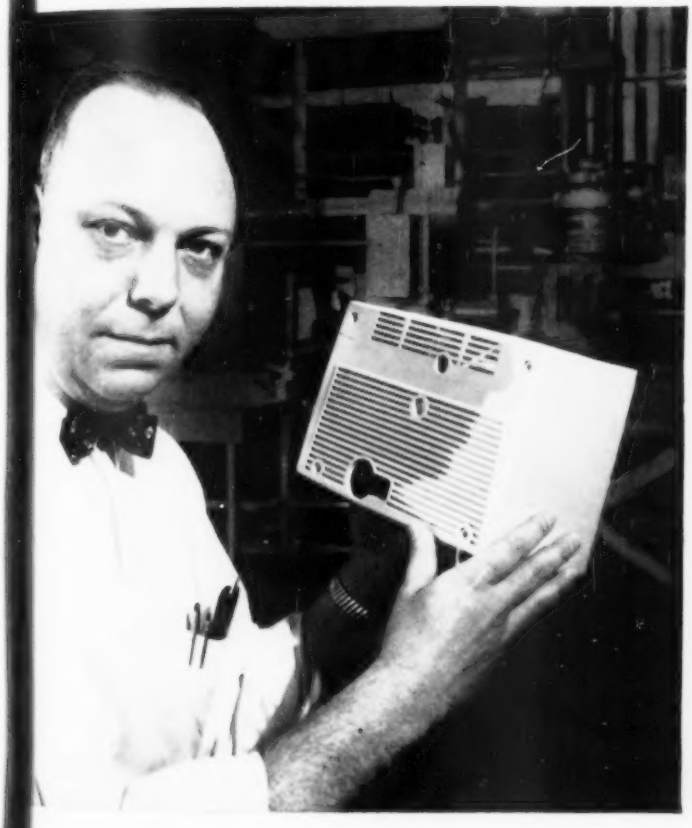

Kenneth J. Sweet, Bridgeport Moulded Products, Inc., Bridgeport, Conn. Factory Manager Sweet has had 17 years' experience in plastics technology. His know-how is solid, gained in such previous jobs as production expediting, tool designing and mold construction. He now supervises 300 technicians and the operation of 27 injecting molding machines. Custom products molded by his company include items as small as 2-oz. radio knobs, as large as air-conditioner front panel sections. Production averages two million plastic parts weekly—all to exacting customer specifications.

Ernest R. Bozzell, Amos Molded Plastics Co., Edinburg, Indiana As molding superintendent for a 70-operator shop that custom molds three shifts daily, Bozzell brings 12 years' experience in thermoplastic molding to the job. Contracts range all the way from hose couplings to television masks. Bozzell started the production of one of the largest parts ever molded: a 7 lb. refrigerator door liner. He later molded a liner perforated with 78 holes for mounting. Comments Bozzell: "Practically every custom job is different and few of the answers can be found in books."

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By A. R. Morse
President, Injection Molder's Supply Co.

"It is the freedom to disagree, to quarrel with authority, in intellectual matters to think otherwise, that has made this nation what it is today." Dr. James B. Conant

MEMO TO SALES ENGINEERS

Readers of this column — and its various editors, critics and censors— can brace themselves for a paragraph or two each month now on on the 1956 SPE Technical Conference to be held in Cleveland next Jan. 18, 19, and 20. Every effort is being made to make these sessions the best yet.

There is a basic trend that every technical society faces today — that is toward becoming a mere group of SALES engineers, instead of plastics, rubber, chemical, mechanical engineers. Remember SPE started out as a group of sales engineers. No official breakdown of our membership is available, but every SALES engineer —and we are loaded—should make it a point to secure at least one molder-processor sponsor for the 1956 sessions. To this end the registration fees have been sensibly reclassified and lowered, so that molders, processors and tool-makers can come in under a new low $25.00 fee. This modest amount entitles the registrant to one free registration, free admittance to all sessions; free listings under company and individual name in programs and bulletins; to preferential treatment in assigning of the limited number of suites; and signifies a contribution toward the educational aims of SPE. Yes, if we are going to combat the trend toward "sales engineers meetings" we must get out more molders to tell what they need in the way of materials and equipment — more users and buyers of plastics to tell about their problems. So Sales Engineers, set your sights now to bring more molders, mold makers, and processors, users and buyers of plastics to the 1956 Technical Sessions. "Plastics Progress Presents" many snappy programs that will interest and inform them! Begin to talk up Company Registrations now, it's not too soon!

PLUNGER GALDING

There seems to be a rash of plunger galding in the trade right now. On some machines the plunger does not enter the heating chamber. On others it may go into it anywhere from 1 to 11 inches. Plunger galding is no respecter of anything — it may occur overnight on a brand new press; or after years of safe operation it will crop up on an old machine. The range of plunger-sleeve tolerances now in use ranges from a low .002 to as much as .060. The range of plunger steels and hardness is equally as varied. To prevent galding, chrome plating, nitralloy, case hardening, soft vs. hard steels, and reliefs of all types have been tried with varying degrees of success.

What guides the injection plunger? Actually not much except the packing gland. What causes galding? There seem to be a variety of causes: lack of cooling; too long plunger dwell; various types of materials and granulations; lack of supervision at purging and startups; worn couplings; improper press alignment; and particularly worn or loose packing glands. Another cause of galding is bottoming the plunger in feed weighing. At the very end of its stroke the injection plunger tends to take an awful dip. At maximum squeeze or push, it can often strain machine members and go way out of line, starting galding that will carry over the whole stroke. Running with a cushion prevents the plunger from receiving this final surge of misalignment from the press, and can cut down on galding from this cause. Now many galded plungers work perfectly well, and need not be replaced unless they are throwing metal or streaking black into the material. With adequate relief, some galded plungers will actually clean themselves, and disgorge dirty flash to the rear. But all too often galded plungers and sleeves are merely replaced and not enough investigation is made of the basic cause of the trouble so it soon recurs.

Worn or loose couplings should always be replaced. Packing glands should be renewed and tightened. All injection oil cylinder bolts should be equally stressed and alignment of the plunger checked with the new sleeve both under pressure and without pressure in the oil cylinder. These are all somewhat time-consuming and hard things to do, as the work of loosening the oil cylinder bolts and re-aligning them etc. is very heavy, and yet results must be measured to the tenth using precision indicators.

Other steps can be taken too. If many fines are present, screening may called for. Provision for cooling to the plunger can be considered, though this is expensive and not always necessary if everything else is OK— especially the tolerances selected for the plunger and the method of relieving the feed cylinder. Actually the only fool-proof way of preventing plunger galding is to provide a positive guide for the plunger — a somewhat costly addition to the press necessitating re-design. Barring this, new packings evenly tightened, a comparatively close fit of the plunger at the rear of the feed sleeve of from .002 to .004, adequate relief of the internal portion of the sleeve of from .030 to .060; and constant attention to usually neglected alignment of the heavy injection end components are the best ways to avoid this costly trouble.

It goes without saying that the heater should be correctly aligned with the feed sleeve. This should be checked by actually feeling of the joint with the finger where possible, or by a wire probe otherwise. Earl Horton of Kusan, one of our leading plastic engineers, is testing a relief of .060 where the plunger enters the tunnel on a 32 oz. press. He feels that the "step" (as long as it is in the direction of the powder flows) is one solution to galding of plungers on those tunnels where the plunger enters them. We have encountered such a variety of dimensions and tolerances here that the extra relief can certainly do no harm—and it actually seems a better "out" than using a hardened steel insert or sleeve which can crack or leak.

Vertical presses sometimes give the impression of having less galding than horizontal ones. This would point to the material pile in feed sleeve as a cause of galding, as the plunger has more material to push at the bottom than the top— and of course it tends to "ride up" on the fines or flash. Actually this is a minor cause of trouble, and I believe that wear and other factors discussed above are worse offenders here than basic press design. Galding comes in spurts in certain plants indicating that definite causes must exist—but they are not easy to locate and correct, so that most remedies consist merely of continued and costly plunger and sleeve replacements instead of getting at the cause of the trouble which actually may go as deep as a complete overhaul and precision realignment of the whole massive injection end oil cylinder assembly — a thing which very few plants are equipped or willing to do.

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AROUND THE WORLD

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BRAZIL

REVISTA BRASILEIRA DE PLASTICOS

February, 1955

Abstracter: Louis A. Helwich

NEW MATERIALS, NEW TRIUMPHS—Eugene Clute. Page 4.

Foamglas has been used as building material to produce a large sculpture in the dining room of the S. S. United States, on account of its lightness.

A GREAT EXHIBITION OF THE BRITISH INDUSTRY—Page 8-11.

The principal features of the British Plastics Exhibition in 1953 are given, which aroused international interest.

COMPRESSION MOLDING — Eric Jeanrenaud, Page 19-21.

A continuation of articles on plastics engineering problems. The question of uniformity of wall thickness of the molded piece is discussed.

March, 1955

COMPRESSION MOLDING — Eric Jeanrenaud. Page 12-14.

A continuation of the plastics engineering series. Details of mold design are discussed.

JUGOSLAVIA STARTS PRODUCTION OF POLYVINYLCHLORIDE— Page 19-21.

The post-war modern PVC production plant of the Jugovinil was constructed in the last five years near the town of Split. All newest developments in this field have been utilized. It produces basically 4 types of polyvinyl chloride: Type 505 for rigid moldings, type 606 for elastomeric applications type 707 a paste resin and type 808 a cable coating material. Other products are molding compounds in granulated form and finished rods, pipes and sheets. The products have already found introduction on foreign markets especially in Germany, France, Italy, Austria and South America.

April, 1955

SOME PROPERTIES OF PLASTICIZERS OF "MOLLAN" TYPE—Otto Pesta. Page 6-9.

The products of Oesterreichische Stickstoffwerke from Austria, which are being introduced in Brazil are discussed and their properties given.

THE MANUFACTURE OF "LONG PLAY" RECORDS—Page 10-12

A description of a new factory in Petropolis near Rio de Janeiro is given claiming an annual production of plastic phonograph records of 4.5 millions.

HOW TO ESTIMATE THE PRICE OF MOLDED PIECE — Eric Jeanrenaud, page 23-26.

Basic considerations for the calculation of price with practical examples.

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BELGIUM

MATIERES PLASTIQUES

No. 72, Sept.-Oct., 1954

Abstracter: Alfred P. Daignault

APPLICATIONS OF POLYESTER RESINS, Pg. 13

A summary of some applications and methods of using polyester resins.

INDUSTRIAL APPLICATIONS OF PLASTICS. W. M. York, President of Publicity Committee of the British Plastics Federation, Pgs. 14-16

This article points out that ⅔ of British Plastics go into industrial applications. Of these it lists nylon gears for the textile industry, polytetraflouroethylene gears, airplane wings bonded with phenolic resins, synthetic resin adhesives for bonding metal to metal, phenolic laminate insulators, polyethylene coated wire, acrylic radomes, vinyl conveyor belts for mining applications, shell molding resins, pipes for maritime and chemical plant applications.

PLASTICS IN HOME BUILDING AND DECORATION. (Illustrated) Pgs. 19-22

a. Formica decorative laminates.
b. Rigid vinyl sheets for luminous ceilings.
c. Rigid PVC ducts for smoke evacuation.

ELECTRONIC SEALERS FOR PLASTICS. R. Paquet, Pgs. 23-26

Discusses the principles involved, the types and construction of equipment and the advantages derived from use of electronic equipment for sealing thermoplastic sheets and film.

PLASTIC TUBING FOR ELECTRICAL CONDUITS AND FOR CONDUITS FOR ALL LIQUIDS. Pgs. 27-28

Lists the advantages of rigid PVC tubing which has been approved by the Ministry of Economic Affairs of Belgium as electrical conduit. This article also lists the advantages of its use for tubing for water, compressed air, gas, gasoline, acids, and alkalies.

ILLUSTRATED APPLICATIONS OF PLASTICS. Pgs. 31-34

a. PVC Pipe in Photographic Developing studio.
b. Polystyrene—Models of teeth.
c. Vinyl Film—for bellows in instrument for metabolism studies.
d. Vulcanized Fibre—suitcases.

TRANSATLANTIC CABLE INSULATED WITH POLYETHYLENE. (Illustrated), Pgs. 35-37

Summarizes the replacement of the cable connecting Italy and South America which was cut during the last war. The new polyethylene insulated cable of European manufacture cost more than ⅓ less than the former cable. In addition the amount of copper and steel wire required was reduced by 25% and 17% respectively. The capacity of transmission has been increased by 30 letters per minute. Polyethylene also results in improved resistance to moisture, and abrasion, improved flexibility and chemical inertia. Polyethylene also substantially reduces difficulties caused by attack by sea worms which heretofore have been a major problem of cable maintenance.

NEWS OF THE WORLD.

a. Germany—
   1. Polyester - fiberglass applications.
   2. Exposition of Plastic Materials—Dusseldorf, October 1955.
   3. Synthetic wax.
   4. Synthetic furs.
b. France—
   1. Lighting panels of "Vralex".
   2. New French polyethylene plant.
   3. Latex base paints.
   4. Societe Rhone-Poulenc — new

facilities for plastic material production.
5. Celamine — a new decorative laminate.

c. Holland—
1. New production method for latex dipped articles.
2. New facilities for production of diphenylopropane.

d. Great Britain—
1. Plastics in building construction.
2. Flame resistant rubber.
3. British Plastic exports.

e. Spain—
1. First Spanish nylon plant.

f. Sweden—
1. New facilities for melamine and polystyrene production.

g. U.S.A.—
1. Plastic balloon sets new altitude record.
2. Use of PVC for large equipment in the chemical industry.
3. Packaging of goldfish in polyethylene bags.
4. Reinforced Plastics in the U.S.

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DENMARK

PLASTIC

Vol. 4, No. 9, September, 1954

Abstracter: Erik R. Nielsen

POLYESTER-GLASSFIBER-LAMINATES. Johanne Moustgaard

Second and concluding article on glass reinforced polyesters.

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FRANCE

INDUSTRIE DES PLASTIQUES MODERNES

Vol. 6, No. 10, December, 1954

Abstracter: Hans Mayer

THE RESEARCH CENTER AT AUBERVILLIERS

The research laboratories of the Pechiney Comp. are described in connection with the series of articles on the reequipment of the French industry. It is pointed out that research is not limited to the invention and development of new basic materials, but also covers the control of properties and production methods of existing materials. The testing setup, particularly the pilot plants for the duplication of production runs are enumerated and described.

In the same series of stories the "WINGLES WORKS" (polystyrene), the production unit of Monsanto-Boussois are discussed.

RILSAN IN PACKAGING AND CONDITIONING. R. Dumon

Rilsan, a polyamide resin, is being applied as a safety coating for shipping and storage by means of feeding the powder in closely controlled quantities past the nozzle of a torch. The resulting protective film has excellent adhesion and will follow the contours of the part to be protected. However, the part to be coated needs preparation, it has to be absolutely free of contamination and has to be heated, also by means of a suitable torch, to about 80 to 100 centigrades. The thickness of the coatings can be kept within limits of 3/10 mm. to 10 mm.

Other application of RILSAN as injection molding, extrusion, etc. are also discussed.

Under the heading "Plastics and agricultural by-products" the American Valite process of reducing bagasse (sugar cane residues) to resins of various qualities is discussed.

POLYSTYRENE WALLTILES. J. Delorme

The author describes a new design molded tile which will adhere to ordinary mortar. The tile design includes a frame around the inside border line which is studded with small protrusions which will secure a straight setting and prevent loosening.

MAPS PRINTED ON VINYLITE

The Blondel-La Rougery process of printing maps directly on RETROVYL and the resulting advantages as to resistance to water and temperature are described.

CONTINUOUS MOLDING OF PLASTIC REINFORCED PRODUCTS

The operations of the Glastruder are described and analysed.

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PENSER PLASTIQUES

December, 1954

Abstracter: P. W. Wood

THE EPOXIES—by H. P.

This article discusses in detail the history, chemistry, commercial forms, fillers ,additives, properties, applications, end uses and suppliers of polyesters and epoxies.

REINFORCEMENT OF PLASTICS WITH FIBRE GLASS CLOTH—by M. Duflos

Some refinements in glass cloth for contour molding are discussed.

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GERMANY

PLASTE UND KAUTSCHUK

August, 1954

Abstracter: Walter Brenner

THE PLASTICS INDUSTRY'S EXHIBITS

The first plastics exhibition of the so-called "German Democratic Republic" in Berlin is described. Claims are made for excellent attendance, including foreign visitors from South Africa, Sweden, Switzerland, and Great Britain. Interest of visitors was said to be focused on high quality phenolic and melamine moldings, as well as on rigid polyvinyl chloride and fire resistant cellulosic parts. The newly developed epoxies and polyesters created considerable stir.

Many visitors appeared surprised by the multitude of plastics available and stated that some steps towards standardization for consumer products appeared necessary. There was also some opinion expressed that developments in materials must be accompanied by improvements in machinery design and construction in order to take full advantage of the unique properties of the new plastics.

TORSIONAL MEASUREMENTS OF MIXTURES OF BUNA WITH POLYVINYL CHLORIDE AND POLYSTYRENE—by W. Breurs, etal.

The article describes improved techniques for torsional measurements of mixtures of buna materials with polyvinyl chloride and polystyrene. Design of test squipment is given in considerable detail and many data are presented for mixtures of buna SS, perbunan, and perbunan W with polyvinyl chloride and polystyrene. The dependence of torsional measurements on temperature is also graphically illustrated. The practical significance of the measurements is demonstrated by pictures of cups made with various mixtures after exposure to selected elevated temperatures.

METHODS OF SYNTHESIS OF LINEAR POLYAMIDES FROM FURFURAL—by Kurt Stickdorn

Furfural is a readily available raw material obtained from agricultural waste products such as corn cobs. Techniques are described for the synthesis of linear polyamides starting with this low cost raw material. The methods described include thermal decomposition of furfural, catalytic hydrogenation of furfural, and link opening of furfural based acids. The use of tetrahydrofurane in these syntheses is given special attention. The decision as to whether furfural can be used as a raw material in place of phenol for the production of polyamides depends primarily on its commercial availability. There is every indication that German production of furfural will be considerably increased in the future.

NEW DEVELOPMENTS IN POLYVINYL CHLORIDES—by A. Hoff

The article discusses primary improvements in polymerization techniques of polyvinyl chlorides. New developments in suspension polymerization are discussed. Most of the information presented has already been made available in earlier American publications.

SECTION NEWS

Edited by

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Western New England

200th Member Joins WNE Section Two Speakers Are Featured

M. G. Snyder

A momentous milestone was passed at the March 2 meeting of the Western New England Section (SPE) with the receipt of the 200th application for membership. A large cake, suitably decorated to commemorate the occasion, topped the bill of fare which consisted of a corned beef and cabbage dinner served family style. The 73 members and guests in attendance at the Bradley Field Terrace Dining Room, in Windsor Locks, Conn., later heard slide-illustrated talks by William Higgins of the Bakelite Company and Amelio Cocci of Standard Tool Company. Edward W. Vaill of the Bakelite Company presided as technical chairman.

A summary of the papers presented follows.

Cellular polyethylene sheeting has been made successfully by using a flat die. The most difficult part of this operation is the adjustment of the die temperatures to insure uniform heating across the sheet.

The widest good-quality sheet made so far is 10 inches. The thickness of the sheet is determined by adjustment of the die lip spacing; the material will expand to twice the size of the opening. Drawing down from this size causes the cells to elongate and breaks the polyethylene membrane separating the cells. In this process, many of the desirable properties of the material, which depend on its unicellular nature, are destroyed. Attempts to extrude this material by the blown tubing technique have failed for this reason. The membranes between the cells are broken, the air inside the tube is lost and the tube collapses.

Rods of good quality up to one inch in diameter have been made and presumably other shapes can also be produced successfully, but the sharpness of die detail probably will be lost as the compound expands.

Fabrication of cellular polyethylene by injection molding has not been satisfactory to date. Open die shots give a well-foamed material, much the same as that obtained with an extruder. However, injection pressures required are so high that the gas is either lost or the cells are collapsed in the mold — probably a combination of both. Short shots, in which the mold was only partially filled, did not help, nor did a reduction of ram pressure following the injection stroke.

A technique that may hold promise is to adhere to a normal molding cycle for polyethylene and later treat the molded article in an oven, bringing it close to its softening point. The reduced viscosity of the resin at this temperature permits the collapsed gas cells to expand.

Other aspects of cellular polyethylene discussed by Mr. Higgins at this meeting have already been published in the January SPE Journal.

Second speaker of the evening was Mr. Amelio Cocci of Standard Tool Company, Leominster, Mass. He gave an interesting analysis of the properties, characteristics and advantages of beryllium copper molds. A summary of his talk follows.

Metallurgists have long sought a satisfactory method of combining the strength and hardness of steel with the thermal conductivity and corrosion resistance of copper. After extensive research that spanned a century, they discovered that by adding small amounts of beryllium to several nonferrous metals, the alloys obtained would give them the properties they wanted. Wartime restrictions retarded the widespread growth of this technique for a time, but knowledge gained in that period is behind many of the advanced applications for beryllium copper molds now used in the plastics, rubber and zinc die-cast industry.

The Stan-Cast Division of Standard Tool has thus far processed about 25,000 lbs. of beryllium copper for plastics injection molds. We made our first beryllium copper mold 2½ years ago. Today, approximately 20 percent of the molds we produce contain beryllium copper cavities and forcers, or a combination of beryllium copper and steel. Our heaviest mold of this type produced thus far weighed 360 pounds.

We do not consider beryllium copper cavities and forces as a cure-all for plastics molds. We would rather say it supplements other well-known methods of mold construction. This type of mold, however, is being used to advantage in molding such commercial items as nylon, bevel, spur and spiral gears, auto speedometer gears, dials with raised letters and numerals, automobile lenses, refrigerator parts, radio cabinets and numerous other parts.

The hardening characteristics of beryllium copper are exactly the opposite from those of steel. This is a distinct advantage to the plastics molder because his normal molding temperatures tend to approach the hardening temperature of the alloy. Consequently, cavities and cores for plastics molds made from beryllium copper will remain stable and will last longer.

Basically, beryllium copper alloy, which is used in cast cavities and forces, is composed of the following: 2.75% beryllium, .5% cobalt and the balance copper, which when properly heat treated contains such mechanical properties as a yield strength of 150,000 lbs. p.s.i., tensile strength of 180,000 lbs. p.s.i., and ultimate compressive strength of 300,000 lbs. p.s.i.

Compressive strength can be illustrated by a simple test undertaken at Standard Tool recently. A hardened steel hob ¾" in diameter was driven into a piece of hobbing steel .010" deep. On checking this cavity after pressing, the depth measured .009", indicating a recovery of .001". This same test was tried on a piece of beryllium copper annealed, and much to our surprise the recovery was .009" as compared to the .001" on hobbing steel. We have never found it necessary to resurface a beryllium copper mold (due to compressed areas, etc.) after it was put in use.

Hobs used in the beryllium copper pressure cast system are very seldom, if ever, in danger of breaking or distorting, providing they are made of the proper type steel. Vanadium Hot Form #1 is a suitable steel for hobs which require a limited number of cavities, and where the hob does not have thin projections.

A new type of steel called "Congo Hot Work" does not require heat treating, and may be used on delicate hobs or hobs which will require a number of cavities. Type 18-4-1 High-Speed steel is also a suitable steel for this work, and is generally considered superior to Hot Form #1, but not as effective as Congo Hot

Work. In any event, it is always a good idea to consult a beryllium copper pressure caster before selecting a hob steel to get his recommendations. What might appear to be a problem to the molder may be a simple routine job to him, and he can frequently help you avoid hob failure.

The properties of the beryllium copper alloy, combined with improved casting procedures, offer important cost-saving opportunities in the preparation of molds and the manufacture of plastic parts. For instance—

1. Cast beryllium copper cavities and cores often mean decreased tooling and production costs through the casting phase.
2. Expensive machining can be substantially reduced, or even eliminated. Some cautions should be exercised, however, to prevent misapplication. Beryllium copper is not always the low-cost answer.

Certain types of plastic materials, such as phenolics and vinyls, tend to corrode the beryllium copper alloy. For best results, it is recommended that beryllium copper cavities and cores be chrome plated when the plastic material used is either a phenolic or a vinyl. Beryllium copper can be readily flash-chromed or plated. Chrome-plated beryllium copper has a long life, because the plating tends to wear uniformly and is not likely to develop porosity.

One large molder is using beryllium copper chrome-plated cavities for his compression and transfer molds with a great degree of success. This company is now considering using this alloy for their aluminum die casting dies. In addition, many molders of rubber in the Western New England area are currently using chrome-plated beryllium copper cavities and forces in their molds.

The thermal conductivity of beryllium copper often permits a saving of from 15% to 25% in cycle time. Certain types of moldings, however, will offer little opportunity for savings of this kind because of thin and heavy cross sections.

Beryllium copper cavities and cores have been a great asset, particularly to the novelty trade, because it is possible to cast the necessary cavity and core hobs for such items, leaving the customer with an approximate desired wall thickness, not only on the bottom of the item but on the sides as well. The irregular parting lines on such items usually entail no additional expense. All that is required is a shrink-compensated authentic model which can be used to develop the necessary hobs.

This method can save many man-hours of work on the hobs, and also eliminates duplication of the cores—which can be very costly.

Southern

Plastics Is Your Business

C. Veazey LeCraw

The March meeting of the Southern Section was held on March 21 at Mammy's Shanty in Atlanta, Ga. Speaker for the occasion was Mr. R. J. Savage, Director of Sales of the Marco Products Department of the Celanese Corporation, who delivered a very enlightening talk on Polyester Resins. The molding of a scale model boat during the meeting by the Marco Method highlighted Mr. Savage's talk and demonstrated the simplicity of this method of making commercial items.

The presentation was proceeded by a showing of a filmstrip prepared by the Society of the Plastics Industry entitled "Plastics IS Your Business." This strip reviewed all the major plastic materials used in day-to-day life in America, and described briefly some of the uses of reinforced polyester resins.

Polyester resins are defined as polymerizable thermohardened resins. These are distinguished from polymerizable thermoplastic resins, such as acrylates, vinylites, and styrene, by being thermohardened after polymerization. They are distinguished from thermohardened resins such as phenolics, ureas and melamines because they are produced by addition polymerization rather than by condensation. Thus, polyesters do not give off volatile end products and do not require pressure during molding operations.

As supplied for commercial applications, polyesters are usually liquid in form and as such are actually a mixture of an alkyd resin dispersed in a monomer, usually styrene. The alkyd is produced by reacting one or more di-basic acids in anhydride form, such as phthalic or maleic anhydride, with a polyvinyl alcohol such as propylene or ethylene glycol. Thus the term "alkyd" is derived from "alcid" — a mixture of an alcohol and an acid. This alkyd resin is dispersed in styrene, and the result is a liquid which may range in viscosity from that of water to a heavy syrup or molasses and color from dark straw to water clarity. The amount of styrene present largely determines the viscosity and is generally around 30% of the polyester although it may range very widely.

The liquid resin is converted from a liquid to a hard, insoluble, infusible solid through the action of a catalyst. The catalysts are generally peroxides or hydroperoxides and are supplied as powders, pastes, or liquids. Curing temperatures in the range of 180°-240°F are generally employed to activate the catalyst; however, through the use of accelerators, which are used in conjunction with the catalysts, it is possible to cure the resin at temperatures as low as 60-70°F thus making possible molding at room temperature. The speed at which the resin cures may be controlled by varying the amounts of catalyst, accelerator, and/or heat employed. The most commonly used catalyst is benzoyl peroxide either as a powder, which must be dissolved in styrene, or in the form of a compounded paste, usually known as ATC. This catalyst is ordinarily used in conjunction with elevated temperatures; however it can also be activated at room temperature by certain amino compounds. Cyclohexanone peroxide, supplied as a paste, or methyl ethyl ketone peroxide, supplied as a liquid, are ordinarily used for room temperature cures in conjunction with cobalt naphthenate. Cumene hydroperoxide and lauroyl peroxide are other catalysts not so commonly used, and mercaptins and manganese peroxide are sometimes used as accelerators. The catalyst should always be thoroughly mixed with the resin prior to addition of the accelerator since a mixture of a catalyst and an accelerator are very often explosively reactive.

Since the reaction involved in converting from a liquid to a solid is a non-condensing or addition polymerization reaction, no gases or vapors are given off. Therefore no pressure is required to hold any volatile by-products, and venting is not required in molds. The polymerization of these resins is what is known as an exothermic reaction, and heat is liberated. Thus, there are high exotherm resins and low exotherm resins. Since the rate of reaction can be controlled by the resin manufacturer, there are fast curing resins and slow curing resins. Generally the amount of heat evolved will vary as the rate of cure varies.

The more common resins offered commercially are of a relatively few broad classifications, although many combinations or variations on these types will be found. There are rigid resins, flexible resins, and semi-rigid resins, which are mixtures of the first two. There are many other ways of classifying the three groups of resins. They can be made slow burning or fireproof through proper compounding or through the use of fillers. They can be made light stable to avoid darkening under ultraviolet light, weather resistant, chemically resistant, and/or highly thixotropic.

Various molding methods were discussed and demonstrated including the molding of a scale model of a boat by the Marco Method, hand lay-up, and novelty casting of polyesters.

Newark

Panel on Vacuum Forming Looks At Styrene, Cellulosics, Ethylene

R. Bostwick

The regular March meeting of the Newark Section was held on March 9 at the Military Park Hotel. Approximately 80 members and guests attended the dinner and the panel discussion on forming of thermoplastic sheets.

The meeting was opened by Bob Hoehn and then turned over to Ed Soules. Ed announced that a gala outing has been set for May 26 at the Mazda Brook Farms in Parsippany, featuring both luncheon and dinner and a host of activities and events. The panel discussion then started with Bob Carter of the Celanese Corp. Sales Dept. acting as moderator.

The lead-off speaker was Jack Mighton of Dow Technical Service. Mr. Mighton discussed the high impact polystyrenes. He pointed out the increasing use of vacuum forming of these materials in the sign and display field, and also in the refrigeration industry. In the latter field the new high gloss sheet made by laminating regular polystyrene to the polystyrene alloy sheets has been of particular interest. Another volume field is in housewares and a developing field is in wall coverings.

Mr. Mighton discussed some of the problems in vacuum forming, particularly as regards non-uniform thinning of the sheet on drawing. He stressed the importance of close control of all aspects of the heating, including points of application. The use of the plug technique was also discussed.

Mr. Mighton concluded with a sketch of an idealized continuous sheet extrusion and vacuum forming set-up based on installations now actually in use, featuring a traveling die above the take-off conveyor.

The next speaker, Sanford Zimmerman of Vacuum Forming Corporation, discussed forming equipment. He pointed out that twenty million pounds of sheet were vacuum formed in 1954, with drape forming the dominant technique. A set of colored slides showed the operation of this method vividly and very clearly. Mr. Zimmerman also touched on the rivalry between vacuum forming and injection molding, feeling that each had a place in the plastics industry. A disadvantage of vacuum forming is the need for trimming the ejected piece; considerable advantage is derived from low tooling cost and the possibility of fast tooling for a given product.

The final speaker, Frank Quinby of the Celanese Corp. Market Development Dept., discussed forming of cellulosics and polyethylene. While forming of polyethylene is still in the developmental stage, the cellulosics are in commercial use. Cellulose acetate and cellulose acetate butyrate are being used primarily in packaging of small items. The thickness range is usually from .003" to .020", filling a previous void in the packaging field between thin films and injection molded containers.

A number of well mounted displays were shown, covering the gamut of formed cellulose acetate uses. These included single compartment and multiple unit packages, blister packs and skin packs. The latter two are of particular use in the hardware field. A striking application was bearings capsulated in oil in a multiple unit package.

During the discussion period following the prepared speeches two additional sheet materials were touched upon, vinyl and nylon. It was brought out that vinyl is widely used in the display field because of good registration during the vacuum forming process. In the case of nylon, availability of nylon sheet of uniform thickness is a problem.

Table favors were donated by Dillon-Beck Mfg. Co. Door prizes, all of the liquid variety, were donated by Resistoflex Co., M. W. Kellogg Co., and H. Muehlstein, Inc.

Cleveland-Akron

Polyester Molding at Low Pressures

R. M. Hershey

Approximately forty-five members and fifteen guests attended the March meeting of the Cleveland-Akron Chapter of the SPE. The meeting was held March 14th at the Spanish Tavern in Brecksville, Ohio, and was preceded by a social period and dinner.

Mr. W. E. Wirsch, Low Pressure Molding Department Head of the Rohm and Haas Company's Sales Development Group, presented a colored sound film entitled "Futures Unlimited" and discussed "Polyester Low Pressure Molding."

The film was a joint production of the Zenith Plastics Company, the Libbey-Owens Ford Glass Company, and the Resinous Products Division of the Rohm and Haas Company.

Several present day applications of low pressure reinforced molding materials were covered in the film. Scenes of actual production processes at the Gardena, California, plant of the Zenith Plastics Company, were included. Techniques used in the production of chair seats, radome structures, and airplane fuselages were shown.

Two marked advantages of reinforced polyester plastics are a high tensile strength per unit weight and a low thermal conductivity. Comparative tensile tests conducted on samples of fixed weight and constant width but varying cross-sectional areas construction materials gave results as follows: aluminum, 800; magnesium, 850; stainless steel, 960; and reinforced polyesters, 1735. All units are pounds pull to fracture per unit weight.

On a fuselage section it was reported that in comparison to metal construction, reinforced plastics construction required one-fifth the engineering time, one-sixth the production manpower, and one-seventh the floor space.

Following the film, Mr. Wirsch discussed the history of reinforced plastics with particular emphasis on the applications of the materials.

Reinforced polyester plastics were born during World War II and had three major uses: radome structures, self sealing fuel tanks, and body armor. The largest present day applications include fishing rods, auto parts including the Corvette auto body, and corrugated panelling for awnings and car ports. Mr. Wirsch stated that he believes that the fabricating field is now greatly overcrowded and that the proper application of reinforced polyesters must be closely watched.

The use of premix compounds in order to insure a uniform resin to filler ratio throughout the molding was discussed. The disadvantage of the premix materials is a poor puncture resistance. The Chrysler heater housing was cited as an example of the use of premix compounds.

Work to improve the resin to glass bond, the moisture resistance, and the flame resistance of reinforced plastics was briefly outlined.

Prior to the technical session a brief business meeting was held at which Mr. F. A. Martin of the Hoover Company gave a report on the progress of the 1956 Technical Conference Committee. It was also announced that the Section has purchased a 16 millimeter sound projector for use at the meetings.

Three new members were welcomed to the section at the meeting. They were Mr. Paul Szabo of Pyramid Products, Mr. Sam McElroy of Hercules Powder, and Mr. Andy Kurko of Wilson Products.

Members and guests were advised that the golf outing will be held on June 10th at Columbia Hills Course.

Philadelphia

Borro on Molding Of Thermosets

H. C. Colby, Jr.

The Philadelphia Section's February 22nd meeting was held at the Franklin Institute, 20th & Parkway, Philadelphia. Adolph Kissileff, of Amplex Manufacturing Company, Atlantic City Technical Conference Chairman, thanked all members of the Philadelphia section who had worked so hard to make this conference a success. The detailed statistics of the conference were of particular interest. The highlights were: registered attendance, 1705; reprints sold, 908; and new SPE members signed up 118. Adolph also told us of the many congratulations that had been received on the excellence of the conference.

Ed Derowski, Penn Plastics Company, our new president, introduced his fellow officers: Vice President, Ed Fitzpatrick, F. J. Stokes Co.; Treasurer, Norm Skow, Synthane Corp.; Secretary, Sam Greenwood, F. J. Stokes. Our complete Board of Directors, including three new members, is: Norm Skow, Synthane Corp., Curt Colby, Naugatuck Chemical; Carl Jepson, Du Pont; Ed Fitzpatrick, F. J. Stokes Co.; Adolph Kissileff, Amplex Mfg. Co.; Sam Greenwood, F. J. Stokes Co.; Hank Fuggiti, Exide Battery; Bob Williams, Wilson Products Co.; Allen Hutchings, F. J. Stokes Co.; National Director, Dick Bishop, Foster Grant Co.

The highlight of the dinner preceeding the meeting was a drawing for the two door prizes. They were an RCA Victor 45 RPM record player and a large stack of 45 RPM records. When last seen the two lucky winners were searching for an electrical outlet to conduct a cooperative evaluation of their loot.

Mr. Edward Borro, Customer Technical Service of the Durez Corp., Tonawanda, N. Y., was the speaker of the evening. The subject of his talk was "New Concepts in Compression and Transfer Molding of Thermosetting Materials." Some of the main points of Mr. Borro's talk were; ninety percent of the molder's troubles can be eliminated by proper engineering in mold design. The other ten percent comes from the resins being molded. Heat resistant mineral filled molding compounds can cause difficulties because their fast heat transfer characteristics can give premature cure. The curing characteristics of one stage resins such as ureas can also be a source of trouble. Wherever possible it is desirable to design the part to give the best molding condition. Designing a part only on the basis of appearance can give a piece that is almost impossible to mold.

Allowance of sufficient clearance and control of the rate of closing can do a lot to limit the entrapment of air and other volatiles. Also it is usually true that the lower the amount of flash the quicker the cure. Excessive pressure can give over-size parts and sufficient relief should be allowed to prevent this.

Proper design of the flow section is most important in transfer or plunger molding. Round gates and runners are preferred. Large gates to give effective transfer of pressure are important in limiting part shrinkage. Conditions which tend to allow partial cooling of globs of material in the mold before they can be forced together and knit cause ball joints. These are readily visible as fractures when the piece is dropped. Symmetrical layout of runners is the most desirable to assure even filling of multiple cavities.

Restricted gates can materially reduce mold erosion. Hardened inserts are recommended for these restrictions. A weighed preheating unit is now available to bypass the need for preforms in automatic molding presses.

Mr. Borro's talk was followed by a sporting film, complete with sound and color.

R. I. and S. E. Mass.

Electromolds and Extrusion

Stephen Kalarian

The R. I. and S. E. Mass. section of SPE in February had the largest turnout in its history at a regular monthly meeting. Nearly twice the usual number of people, namely 71, were present to hear Mr. W. T. Stokes of the Electro Mold Corp. and Mr. Phillip Green of the Davis Standard Sales Co.

President Emile Kleiner, G. E. Taunton, Mass., opened the meeting by announcing to the section that a membership drive is on headed by Sydney Lohman, Lester-Phoenix. This drive will end May 1, 1955 and the member who recruits the most applicants will win the first of three grand prizes. Also he and his wife will be guests of honor at the Ladies Nite meeting on May 26th. The section hopes to gain at least 30% more members. From the turnout of this meeting, interest is running high in the activities of this section and the membership goal should be easily realized.

Mr. Stokes of the Electro Mold Corp. commenced his talk by stating there are at least two ways to form a metal piece. First by casting or forging oversize and then machining to size, and second, by casting to exact form. Electro forming approaches the latter in that the mold made is the exact form and no additional machining is necessary. Mr. Stokes explained the steps in electro forming as follows:

1. Start with model made from brass or plastic.
2. Deposit nickel by electrodeposition onto the model up to 5/32 in. thick.
3. Place copper layer on top of nickel for backing.

This then is the general procedure. The model or master is taken out of the electro formed cavity and this cavity is then set into the retainer plate of the mold. It should be noted that the Rockwell of the nickel is C-45 to 50 and the copper backing is approximately 220 Brinnell. Even at injection molding pressures, experience has shown no breaking of the nickel and no settling of the die set into the retainer plate.

The advantages of this method of cavity making are numerous: 1. Exact dimension duplication of master. 2. Exact surface duplication of master to microscopic details. 3. Cheaper than hobbing for small amount of cavities. 4. Conducive to deep narrow sections.

In general this method of mold making is not inexpensive; however, it has its place. It might be said that when other methods of making difficult and complex cavities fail, electro forming could be the answer.

Co-speaker for the evening was Mr. Phillip Green, the President of Davis Standard Sales which is the selling branch for the century old firm of Standard Machinery. Mr. Green spoke about extrusion machines in general. Some fundamentals for a good extruder, he stated, are: 1. Long barrel. 2. Electrically heated barrel. 3. Compact head.

He went on to say that extruders of ten years ago are definitely obsolete. The present day goal is to take the extruding machine out of the field of chance and place it on more of a scientific foundation. Today's machines have the following ranges and improved features:

1. Versatility.
2. 100 H.P. for 6" machine. 7½ H.P. for 2" machine.
3. Speeds 4:1 to 16:1 with V belt drive.
4. Gear box with roller thrust bearing up to 7000 pounds/sq. in.
5. Barrell sectionalized for accuracy.
6. Liners of X-alloy 306.
7. Controlled electric heaters.
8. Cooling by tube sections.

The speaker elaborated on the above items but in particular he emphasized the requirements of the stock screw. This screw or worm should be about 15 length to 1 diameter. The smaller the machine, the larger this ratio. A fast thread lead is recommended with a shallow depth. It is also suspected that better results would be achieved if the worm were electrically heated and controlled! This, however, is in the experimental stage with several companies.

S. E. Ohio

Polystyrene

William J. Stranathan

The Southeastern Ohio Section of the Society of Plastics Engineers had twenty-eight members and guests attending the March meeting to hear a very interesting and informative talk on "Expandable Polystyrene."

After a dinner was enjoyed at the Berwick Hotel dining room, Cambridge, Ohio, President Ray Baker of Fabri-Form Co., Byesville, Ohio had charge of the business session and then turned the meeting over to Paul Brill of Cambridge Panelyte. Mr. Brill introduced Edwin A. Edberg of the Development Section Chemical Division of the Koppers Company Inc.

Mr. Edberg stated that this new material, expandable polystyrene was introduced several months ago and that several companies have been organized to develop uses for the novel material which expands from tiny, hard beads to a substance as light and fluffy as home-baked bread. Instead of baker's yeast, expansion of the plastic depends upon a small amount of an expanding agent inside each bead. The expansion of the plastic beads against the walls of the mold results in the formation of a dense smooth skin. When cool it is light, strong, buoyant, resistant to water and water vapor and more impervious to the passage of heat than cork, glass fibres and mineral wool, which makes it a wonderful insulation material.

New York

Colors in Plastics Are Style Features

A. M. Merrill

"Styling Plastics with Color for Consumer Sales" was the subject under discussion at the March 16 meeting of the New York Section, held at the Gotham Hotel, with approximately 80 members and guests in attendance.

Faber Birren, color consultant, spoke on "Factors and Influence that Regulate Color Trends." He felt that color trends reflect a natural change within an unending cycle, originating with high-fashion and running a three-year course followed by a gradual slackening in popularity. Plastics, as volume merchandise, must follow a consistent pattern using the "vogue" colors. With the use of sales charts Mr. Birren traced the rise and fall in popularity for forest green, chartreuse, and flame red. He noted that pink is the high-fashion color at present, and will reach its peak this year or next.

Practical aspects of color choice and color matching in the molding of styrene housewares were discussed by E. A. Nelson of Monsanto. He described his firm's approach in determining color choice; wherein free merchandise is given to a retail chain for display and customer purchase, without regard to the chain buyer's own color preference. In this manner consumer choice is unrestricted. Mr. Nelson also explained the use of controlled gradation color matching charts, emphasizing hue, lightness, and purity.

As an added feature, a sound-movie entitled "Peelable Plastic Packaging" was shown. The film demonstrated the use of Eastman's Tenite butyrate as a protective film for machine and precision parts.

Table favors were distributed through the courtesy of Monsanto, Plasticraft Corp., and Spec-Toy-Culars, Inc. The meeting concluded with a drawing for door prizes contributed by Monsanto.

Indiana

Epon Story Told Combined Meeting

James Martin

Harvey L. Parry spoke on "Recent Developments in the Use of Epoxy Resins" before a combined meeting of the SPE, The American Chemical Society and the Fort Wayne Rubber & Plastics group. The meeting was held March 15, 1955 at the Indiana Technical College, 223 East Washington Street in Fort Wayne, Indiana.

Mr. Parry received his Masters degree in Organic Chemistry from Emory University in 1943. He worked with the Shell Development Company until 1949, dealing mainly with organic synthesis and polymerization problems. Since then, he has worked with the Union Technical Service Laboratories of the Shell Chemical Corporation. At the present time, he is Senior Chemist in charge of structural application development of their commercially available Epon Resins.

The talk was limited to the structural applications. Slides were used to picture, by graph, the variable properties and limits of variation in the basic qualities of epoxy resins, which are low shrinkage (or thermal expansion controllable as desired by various fillers), adhesion (good shear strength to 500°F now possible), cohesion (best increase in tensile and compressive strength by use of long fibres, such as, glass rather than random fillers, flexural strength by laminates), wettability (as defined from viscosity), chemical resistance (increase of filler decreases chemical resistance generally) and electric properties.

A very lively discussion period followed in the large group that attended, with all questions given well defined answers. Many interesting facts were noted; such as, the infusability and insolubility of the epoxy after thermosetting; ultra-violet light rays darken the epoxy, but do not materially harm it; excellent adhesions to metals; no chipping. The resin has been used to coat insides of pipe lines already laid and has high strength obtainable by room temperature cure without pressure being applied to the material.

This was one of those meetings where groups were still discussing various phases of the subject when they left the building half an hour later.

Miami Valley

Plastic Tooling

M. V. Roode

The March meeting of the Miami Valley Section was held at the Wishing Well Restaurant in Centerville, Ohio, with 36 members and 7 most welcome guests in attendance.

Guest speaker for the evening was Mr. B. B. Curl of the Jonasch Plastics Company who discussed the work his company is doing with plastic tooling in the plastic industry, a field that has not received the publicity accorded its use in metal working.

Mr. Curl noted the increasing use of plastic tools in making prototype molds, checking fixtures, paint spray masks and embossing rolls. He also mentioned their use in the making of heated molds. However, there are definite temperature-pressure limitations at the present time.

The Jonasch Company is working to overcome such limitations with their materials and are developing casting resins that can transfer heat rapidly and that are capable of holding temperatures up to 400°F. for four hours. Prospects, though, for the use of such materials in injection mold cavities, are still not in the forseeable future.

St. Louis

Merchandising

R. S. McDorman

For the March meeting the St. Louis Chapter was fortunate in having as guest speaker Mr. Adrian W. Whited, Plastics Merchandising Div. of Dow Chemical Co. Mr. Whited gave the definition of merchandising work and procedures and illustrations of programs and their development.

A moving picture was shown by Mr. Whited in which Arlene Francis of television fame brought out the high lights of merchandising being done to direct the public in the purchasing of plastic items.

Southern California

Kadlec Reports on Conference; Speaker Tells of Fluorocarbons

Felix C. Karas

The March dinner meeting of the Southern California Section of the Society of Plastics Engineers was held on March 3rd at Scully's Restaurant, 48th and Crenshaw Boulevard, Los Angeles, California.

The meeting was opened by Mr. Walter Kadlec of DuPont who reviewed shortly the events at the recent National SPE Convention at Atlantic City. He also mentioned plans for the establishment of a concerted Educational Program in this area to be jointly promoted with the SPI. He announced the program for the joint session with the American Society of Tool Engineers and the SPE to be held on March 15, 1955, in connection with the national meeting of the ASTE.

The highlight of Mr. Kadlec's speech was the presentation of plaques and gifts of appreciation to the retiring directors of the local chapter: Mr. Austin Herbst, Mr. Dale McDonald and Mr. Lou Tallman, Mr. R. D. Griffith, Membership Chairman made the announcement that the number of members of the local section had doubled in the last three years and had reached 150.

The Program Chairman, Mr. W. DeWar of Standard Plastics introduced the speaker of the evening whose topic was "Fluorocarbons — Resins for Extremes."

The speaker, Mr. Clarence Howard of W. S. Shamban and Company of Culver City, California, opened his talk with outlining the place of the fluorocarbons in the general field of application. Their chemical inertness, wide temperature range (300° to 500°F), zero water absorption, extreme low coefficient of friction, high dielectric strength, good arc resistance and low power factor have made possible the solution of many problems that up to now seemed insurmountable. Teflon was discovered by a scientist working in a DuPont Laboratory. Its pilot plant production started in 1941, while its first commercial plant at Parkersburg, West Virginia, started operation in 1950. Kel-F's history is tied in with the Manhattan project, more precisely with the Oak Ridge U-235 plant which was designed by the M. W. Kellogg Company. Dr. W. T. Miller of Cornell University was the first to produce laboratory quantities of Kel-F.

Teflon can be processed with techniques similar to those used in powder metallurgy and ceramics. Rods, tubes, sheets, V-rings, washers and insulators can be fashioned. By coining and hobbing of appropriate preforms, more complicated and precise parts can be obtained. Teflon can be extruded either in conventional shapes or into a vise for insulating purposes. It also is supplied in the form of aqueous dispersion for film casting and enamel type coatings.

Kel-F behaves like a real thermoplastic. It can be molded by compression, injection, transfer and extension methods. Sheets of Kel-F may be formed by the use of a double platen arrangement.

Teflon and Kel-F can be fabricated, machined, sawed, drilled, reamed, tapped, turned and threaded almost like wood or metal. There are special measures to be taken to accommodate certain properties of the fluorocarbons.

When subjected to a higher temperatures, toxic gaseous decomposition products are given off by the fluorocarbons. Adequate ventilation is a simple and effective solution.

The fluorocarbons are used in the electrical and electronics industries for their unique combination of excellent electrical, thermal and mechanical properties. In chemical equipment, they are used because of their extreme inertness and resistance to chemical corrosion. Gaskets, packings, diaphragms, bearings, tubings made of fluorocarbons have displaced corresponding parts made of conventional materials. In the packaging industry and in the baking industry, the "anti-hesive" characteristics of the fluorocarbons have made them extremely usable. The plastics industry has found that fluorocarbons can be used very successfully for mold releases and protecting covers in potting operations.

The fluorocarbons are still in their infancy. There are numerous possibilities which at the present barely have come into use.

Rochester

Kodak Visited

W. B. England

The January meeting of the Rochester Section featured a visit to the injection molding section of the Eastman Kodak Company, Kodak Park Works. The group of about 36 persons was greeted by Mr. Hotchkiss who introduced Mr. H. Vivian, our host for the tour. Mr. Vivian pointed out that one consideration of plastic use is that plastics must frequently compete as a replacement for ferrous materials. If this is to be accomplished the plastic part must be made to replace several operations or parts required in steel as well as to run with a minimum amount of labor. In addition, the quality must be as good or better.

The above consideration was best illustrated by the operation fabricating the 8 mm movie projector reels. The part is made from Tenite II and from an operational standpoint, is superior to its counterpart in steel in that it does not take a permanent set or bend in handling. The operation is set up with two automatic machines feeding parts to a central point, by conveyor, at which point one operator magazine loads a finishing machine (for gate removal) and layer packs the completed parts. Plastics in this case replace three or more metal parts which would normally be assembled.

Two other interesting jobs that were running at the time were the film spool for the Brownie Camera and slide box for 35 mm slides. The latter part was made from styrene, and required three secondary operations — assembly of a hinge, spring lock and a hot stamping. Some of the new developments being employed which are advancing the plastic industry were vacuum hopper feed, auxiliary air operated comb bar (for positive removal of parts) and a very sensitive strain pick-up to eliminate mold breakage due to hanging parts or material between parting surfaces.

After the social hour and dinner, the President, Mr. J. Delaire, conducted the meeting which included a first showing of a film soon to be available, entitled "Plastic Pipe Lines." This film was procured through the courtesy of Mr. E. Cathcart of Eastman Chemicals Products, Inc., Rochester office.

The film was in color and sound and very well presented. The picture portrayed the field application of plastic tenite pipe for use with water, gas and oil; the methods of application; and advantages over steel.

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Connecticut

Salvage of Molds Described

David Mersey

The March program for the Connecticut Section was sponsored by the Eutectic Welding Alloys Corp. of Flushing, N. Y. Mr. John Duffy showed the color film, "New Welding Procedures;" and delivered a talk on "Salvage of Dies Used in the Plastics Industry." He was assisted by Mr. Martin Turk.

The movie which opened the program showed a vivid portrayal of the principle of surface alloying. Here, a sheet of copper (melt 1980°F.) was used with an aluminum rod (melt 1000-1075 F.) with the correct flux. The flux was applied to the copper sheet, and on the application of heat with an acetylene torch (1050°F.) a new alloy was formed between the aluminum and the copper. This new "surface alloy," descended through the copper sheet, thus making a "copper fusion" at 800 degrees below the melting point of the copper. This principle is fundamental.

Another principle shown in the film and carried over into the spoken portion of the program is: a determination of the type of base metal in the damaged tool goes a long way toward a successful repair through welding techniques. Once the base metal has been determined, the next step is to match the electrode or gas rod to it. Thus the materials developed by this company may be used in welding, beryllium copper, aluminum, Kirksite, and the various steels. Steels, incidentally, break down into four classifications: **a.** water hardening; **b.** oil hardening; **c.** air hardening; **d.** hot working (including high speed steel).

Many actual cases of repairs were shown. In one of these, the force of a positive mold developed a crack which ran diagonally across the face. The crack was ground out to remove sharp edges and fatigue metal, then filled, polished, and put back into operation. Another case involved the stripping of the threads of the cylinder head of an injection press. In other instances, repairs were made to dies where the damage was caused by erosion or "wash out." "Build-up" was made to meet original dimensions; or after correct build-up was made, the force or cavity was re-engraved to carry the detail of the original tools.

In the question period which followed, many immediate problems were analyzed and recommendations made. The meeting was called when time started to run out.

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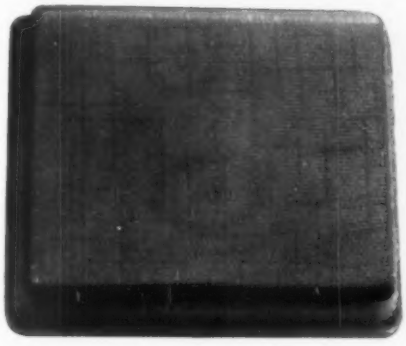

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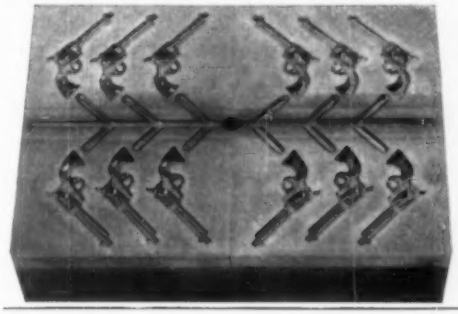

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Since the cavities are formed hard and are not subjected to heat treatment, greater accuracy can be achieved in irregular shapes such as cavities for plastic gears.

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Detroit

Injection Molding Of Fiberglas

Mac Nichols

Mr. Rexford H. Bradt, President of the Fibrefil Corporation in Warsaw, Indiana was the technical speaker at the February dinner meeting of the Detroit Section held at the Rackham Memorial Building.

Mr. Bradt's lectures covered the applications of, and the results that have been obtained from the use of "Fibre Glass Reinforced Injection Molding Compounds." Through Mr. Bradt's efforts fibre glass dispersion (acrylic plus fiberglass) grew from a series of laboratory experiments into the rapidly growing industry it is today.

As a result of continuing research in this relatively unknown field, there is being offered to the designers and fabricators a plastic material that has been called the "micarta" of injection molding. The fibre glass compound when molded is dimensionally stable, can be chilled to -62 degrees F. and subjected to continuous boiling without any trace of crystallization. It can be successfully molded through pin point gates and the thinnest flash shows no evidence of fibre separation from the resin. The material has from 200% to 300% greater impact strength than general purpose styrene and is highly rigid as well as easily machined, punched, cemented and painted. It can be molded on standard injection molding equipment, and because it "sets" faster, a shorter molding cycle is possible. It molds to a milky white color in its natural form and is available in any color.

Mr. Bradt's wide range of experience as an engineer and chemist in industry as well as the atom bomb program has opened new horizons for manufacturers and molders.

N. W. Penn.

Industry Grows

Edward A. Zacks

We are very sorry to announce that we have lost our President, Jack Brecker, who has moved from the city and is now located down in New Jersey. His position as President has been filled by Ed Hileman of Sylvania Electric, Warren, Pa., and W. C. Conroy of Erie Resistor was elected Vice President to fill Ed's old post.

Out amongst the industry in our Chapter, we understand that quite a few of the people have been, and are, vacationing. Chuck Warriner and John Speck of Sylvania were down to Georgia a couple of weeks ago, playing golf on Ike Eisenhower's course. Lee Berry and the Mrs. (Quinn Berry Corp.) are on a trip into the South Pacific to catch up on a little rest. Another vacationer, Tom Crawford and his wife, (Chief Engineer at Perry Plastics), are vacationing in the sunny Florida climate.

Bob Yates, President of the Yates Co., has officially announced that they will be taking on new floor space within a month, this being an addition to their present location, and will double their present floor space.

Another growth is Byrd Plastics, and Bill Byrd advises that they are entering the houseware field as a proprietary line. As a matter of fact, they have just brought out a new dinnerware set called "Tranquil Dinnerware." Bill also announces that Leo Schmelzer has been appointed as Molding Superintendent.

Erie Plastics, who has been expanding rather rapidly in the reprocessing and custom-coloring field, is announcing the appointment of Edward Elder Superintendent of Production.

The next meeting for the Northwestern Pennsylvania Chapter is being scheduled for March 24th and will be in the form of a dinner meeting at one of the local clubs in Erie. Aaron Wagner of Quinn-Berry, who is in charge of this meeting, has scheduled a very interesting affair. Mr. S. A. McElroy, Plastic Sales Representative of Hercules Powder Co., will be the guest speaker and we will also have the SPE film "Plastic Is Your Business."

Kansas City

Bakelite C-11

John R. Albert

After dinner at Millemans Restaurant, on the Plaza, the fifth meeting of the group, with 43 in attendance, was called to order by the Secretary, K. A. Kaufmann, in the absence of the President and Vice-President, the evening of March 1st.

Mr. Alan Donaldson of Bakelite showed a sound color film "Flight to the Future," after which the speaker of the evening, Mr. Harold Holz technical representative of the Molding Materials Department of Bakelite in St. Louis, Missouri, spoke on C-11 styrene acrylonitrile copolymer and its injection and extrusion applications. The information on this newer C-11 was most interesting to all who attended.

After a short business meeting and the awarding of four door prizes, one donated by the Albert Tool & Gage Co. and three by Avsco, Inc. the meeting adjourned.

Necrology

It is with regret that we note the death, on February 27th, last, of Mr. H. Archie Smith, P. Eng., late of 18 Beechwood Crescent in Toronto, an active member of the Toronto Section of the SPE.

Mr. Frank H. Kennedy, Electronic Wave Products, Inc. New York City passed away February 15, 1955.

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Golden Gate

Recent Progress In Nylon Resins

Richard G. Newhall

The Golden Gate Section met on March 24 to hear Ed Rogers of Du Pont report on recent developments in the application of nylon resins. The speaker said that there are three major types of nylon available commercially from Du Pont: The oldest is Type 6 (caprolactam) which is designated Zytel 211. This was originally used in textile applications, but it was found that the presence of some unreacted monomer produced a skin sensitivity in some 10% of the people who came in contact with it. This grade is now used primarily for injection molded parts where high impact strength and good flexibility are desired. Type 66, sold as Zytel 101, is the general purpose member of the family. It was introduced shortly before World War II to replace nylon 6 in textile applications and is now widely used for this purpose as well as for injection molding. Nylon 610, known as Zytel 31, is a very tough resin with good flow properties. It is used in such applications as bristle manufacture and wire coating.

Although an almost infinite variety of nylons is theoretically possible, the other Zytels now on the market, such as 61 and 91, are blends of two or more of the three basic types, sometimes with the addition of plasticizers and or fillers.

The speaker also touched briefly on Du Pont's new polychemicals department sales service laboratory in Wilmington. This facility has been established not only to help in solving customers' problems, but also to do basic research on molding and extrusion. The laboratory is currently engaged in an exhaustive study of the injection molding process, particularly with regard to conditions in the melt itself. The installation of a thermocouple and a Bourdon type pressure gauge extending into the melt just downstream from the breaker plate, has already led to some valuable correlations.

The talk was followed by a display of some examples of novel and intricate nylon molded pieces and a lively question and answer period ensued.

President John L. Morrill then announced the following Committee Chairmen for 1955:

Program — L. E. Faber, Precision Manufacturing Co.

House — Julius Palen, Rembler Co., Ltd.

Publicity — Richard Newhall, Western Plastics.

Membership & Credentials — James C. Smith, Reichhold Chemicals, Inc.

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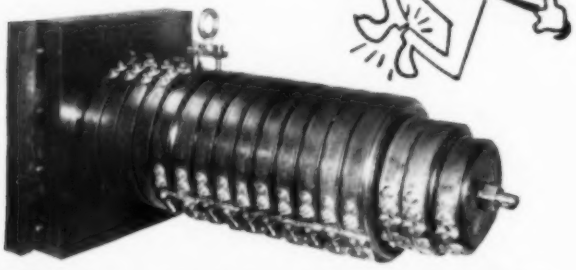


IMS EXTRA CAPACITY SUPERHEATER

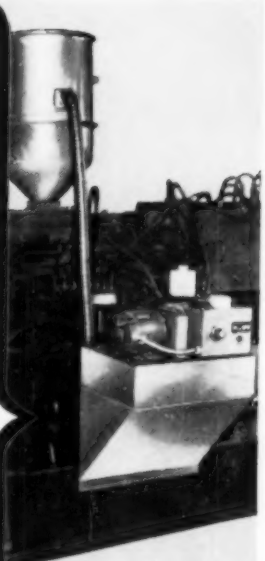
OVER 250 INJECTION MOLDERS
have already successfully increased their production on older machines with IMS uniform design Extra-Capacity Superheaters. Now — old presses can often beat new ones — save the cost of a new, larger machine!

STEP UP PRESS CAPACITY 10 - 50%
We engineer and build IMS Standardized Design Heating Cylinders for REED - PRENTICE, HPM, WATSON, LESTER, IMPCO, etc. Records show maintenance costs often are lower, too! Let us engineer new competitive life into your old press today! Write for details and prices.

INJECTION MOLDERS SUPPLY CO.
3514 LEE ROAD WYoming 1-1424 CLEVELAND 20, OHIO

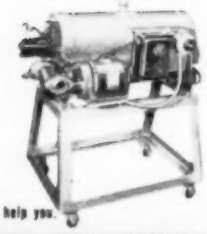
Upgrade Plastics Production . . . Downgrade Costs . . .

D&W HOPPER-DRYER



Efficient pre-heating and de-humidifying of material is just one of many jobs done by this timesaving accessory. It speeds production by eliminating handling—because material goes directly to the machine from receiving. No need to load and unload drying ovens. You save floor space, too, because the Hopper-Dryer can be installed easily on standard makes of injection or extrusion machines. Initial cost is less than a drying oven's. Operating cost is low, results are sure.

New Hopper Loader — For continuous automatic feed of any injection or extrusion machine. Clock timer control for starting and stopping. Dust-free operation. **"Die-Temp" Control** — Positive-acting, self-contained mold temperature control at any level between 100-400 degrees F. Fast, compactly built to save space.



Write today for complete information on how all three of these machines can help you.

THORESON-McCOSH, Inc. 18208 W. McNICHOLS RD. DETROIT 19, MICHIGAN PHONE: KENWOOD 1-8877

Classified Ads

MIDWEST INJECTION MOLDER needs services of an engineer and estimator. Must have engineering degree and good background in mold design and injection molding process. Excellent opportunity for right man with a progressive firm with excellent reputation in custom field. Reply to Box No. 1055 SPE Journal, 34 East Putnam Ave., Greenwich, Connecticut.

Representative

WANTED FOR FULL LINE OF PLASTIC TOOLING RESINS

Experienced salesman, to cover Florida, Georgia, Alabama, Louisiana, Mississippi, Tennessee, North Carolina, South Carolina, West Virginia, Virginia. Should be familiar with tooling and metal forming methods. Engineering background helpful. Should be capable of assisting present customers and developing leads and inquiries turned over to him. Give complete details of education, experience, earnings, in letter to: The MARBLETTE Corporation, 37-21 Thirtieth Street, Long Island City 1, New York.

ENGINEERS — ADMINISTRATORS — SALESMEN — EMPLOYERS. Confidential, rapid and professional service for nation wide placement in the Plastics field. Write giving age, education and brief experience. Employers send us job description. We will let you know how we can help you by return mail. Graebner's Plastics Exchange "The Nation's Largest," 116 South Michigan—Chicago 3, Ill.

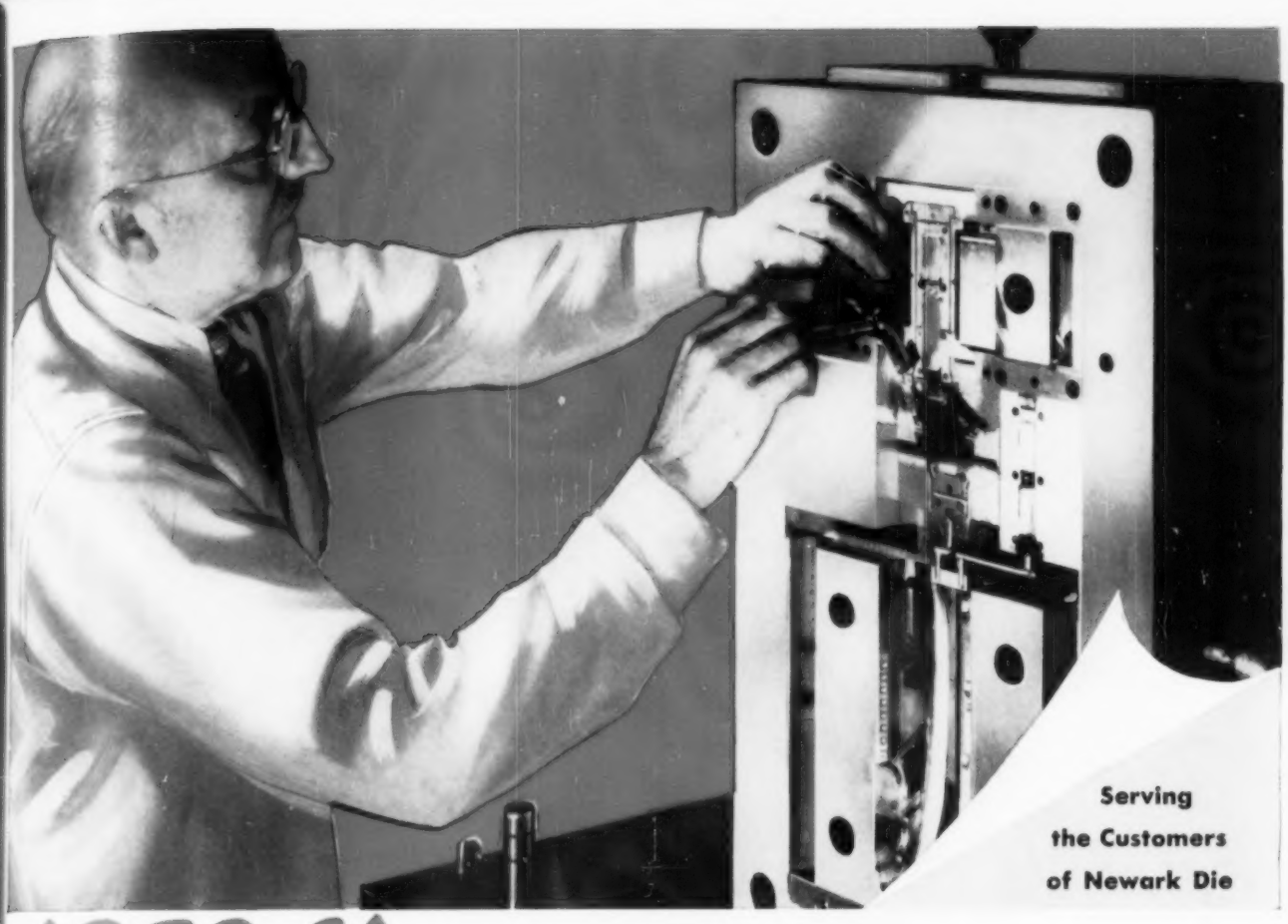
Situations Wanted

Plastics Engineer—Family man, 26 years old, B.S. in Mech. Eng., and member of SPE. Three years of varied experience in product development including extrusion, vacuum forming, and welding of rigid PVC; also hand layup and matched metal die molding of polyester reinforced laminates. Presently employed in another field but would relocate for position with a future in the plastics business. Reply to Box 955 SPE Journal, 34 E. Putnam Ave., Greenwich, Conn.

Illuminating Society To Meet in Canada

The correlation of better lighting to health, safety and efficiency will highlight discussions at the twelfth annual Canadian Regional Conference of the Illuminating Engineering Society in the Mount Royal Hotel here on May 11, 12 and 13.

Several hundred lighting engineers, designers, architects and others interested in illumination are expected to attend from across Canada. The agenda will include papers on such subjects as "practical factors affecting the choice of light sources for various applications" and "new street lighting developments in Toronto." For information, write to Information Committee, 1955 Canadian Regional Conference, Illuminating Engineering Society.



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the Customers
of Newark Die

1,259 Years OF ACCUMULATED SKILL*
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OVER 50%* OF THE PERSONNEL
of Newark Die have been designing and making precision molds for 15 years or more

Making the plastic *molds* that produce accurately sized plastic *parts* is a job that calls for the specialized knowledge gained *only* through years of experience.

Here at Newark Die, molds are designed by engineers with many a year of experience — built by seasoned craftsmen operating the most modern machine tools. This men-and-machines combination brings you the precision molds that meet your most exacting requirements!

That's the through-the-years story of Newark Die. Just a few months ago, we enlarged and rearranged our mold-making facilities to permit us to serve our customers more promptly — and to maintain and strengthen our position as leaders in the field of precision molds.

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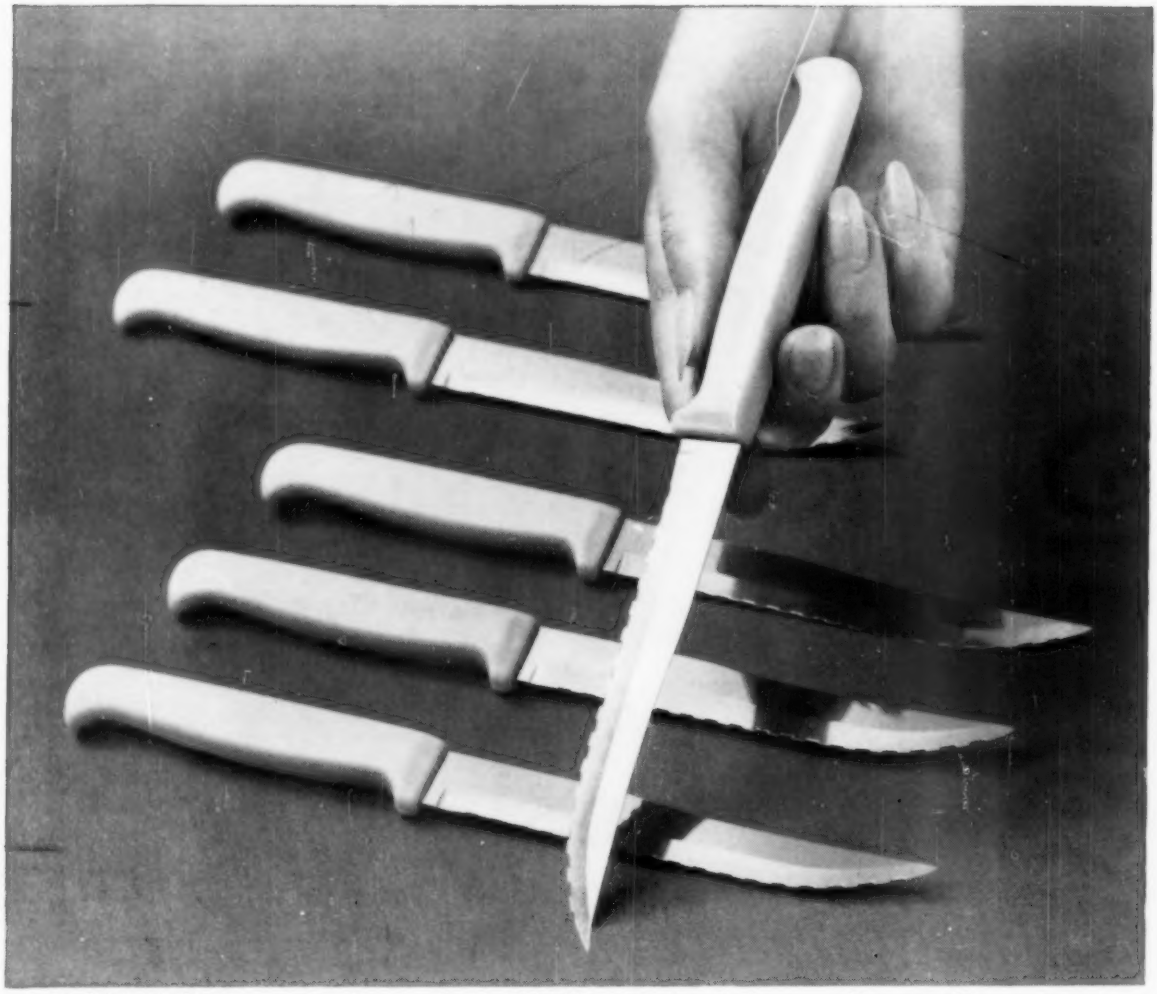

SOLID COLOR pistol-grip handles, combined with highly polished steel, grace any table setting. These units and others, in a wide assortment of gift items and sets, are manufactured by Quikut, Incorporated, Fremont, Ohio.

Hercocel—the high-quality acetate plastic—is the perfect companion for Quikut's high-quality, stainless steel cutlery. It's a combination that cannot help but move merchandise fast—with a value far beyond the premium's actual cost.

Quikut uses colorful Hercocel handles for the two types of hollow-ground knives shown here—in glamorous "pearl" and handsome solid colors. Durable and washproof, these handles retain their luxury look and feel through years of use.

Premium buyers who want beauty, utility, and sell appeal at modest unit cost look for products made with Hercocel—the high-economy, high-quality plastic.

GLAMOROUS "PEARL" Hercocel handles give a rich luxury look to this line of Quikut stainless steel knives.

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